III. Evaluation of the Air Exposure Pathway

This section presents ATSDR's evaluation of the air exposure pathway for the TSCA Incinerator. The PHA focuses largely on the air exposure pathway because it presents the most likely route by which residents might come into contact with the incinerator's environmental releases. ATSDR considers other exposure pathways (e.g., drinking surface water, contacting soils, eating fish and other locally harvested food items) in Section V of this PHA. Further, ATSDR is currently preparing another PHA that evaluates off-site environmental contamination levels in multiple media, whether that contamination originates from the TSCA Incinerator or from other sources.

This section describes the use of a screening procedure to identify contaminants of potential health concern for the TSCA Incinerator; Section IV then evaluates the public health implications of exposures to those contaminants. This section begins by describing the methodology ATSDR routinely uses to evaluate air exposures (see Section III.A), and then reviews what contaminants have been measured in the TSCA Incinerator's air emissions (see Section III.B), how those contaminants move through the air (see Section III.C), and what levels of contamination have been measured in the local air (see Section III.D). Those interested in only an overview of the air exposure pathway should refer to the summary (see Section III.E), which synthesizes the information on emissions, fate and transport, and ambient air monitoring.

III.A. Introduction

ATSDR's public health assessment process emphasizes the importance of exposure pathways, or the different ways that people can come into contact with environmental contaminants. Analyzing exposure pathways is important because, if residents *are not exposed* to a site's environmental contamination, then the contaminants cannot pose a public health hazard and additional analyses are not necessary. If residents *are exposed* to site-related contaminants, then further analysis is needed to characterize the exposure — that said, however, the fact that exposure occurs does not mean that residents necessarily will have health effects or get sick. In fact, for many contaminants, environmental exposures are often far lower than the exposures people experience through their diets and perhaps through their occupations. In cases where exposures do occur, ATSDR must answer several questions to understand the public health implications:

- To what contaminants are people exposed?
- How often are people exposed, and for how long?
- What are the contaminant levels to which people are exposed?

These are just some of the issues ATSDR considers when assessing whether harmful health effects might result from exposure.

An initial step in the exposure pathway evaluation is clearly defining the issues to be evaluated. As stated previously, this section focuses entirely on the air exposure pathway in order to address the issues of greatest concern to residents. ATSDR has not overlooked the possibility that contaminants released from the TSCA Incinerator might be found in other environmental media (e.g., surface water, groundwater, soil). Rather, ATSDR will consider this possibility in an upcoming PHA that examines an extremely broad data set of recent off-site contamination levels. To define further the air exposure issues for this PHA, ATSDR identified the populations of concern and the time frames, locations, and contaminants of greatest interest. The text box below outlines the scope of the air exposure pathway evaluation.

Scope of the Air Exposure Pathway Evaluation

Who: What populations are considered in the exposure evaluation? As Section II explains, this PHA addresses exposures that local community members might experience, outside of any ORR-related occupational exposures.

When: What exposure time frame does this PHA consider? This PHA examines exposures only for when the TSCA Incinerator conducted routine operations—1991 to the present. Future exposures may occur as long as the incinerator operates.

Where: Over what area does this PHA evaluate exposures? Modeling studies predict that the highest residential exposure levels to the TSCA Incinerator's emissions are at off-site locations nearest to ETTP, and exposure levels steadily decrease with distance from the site. However, there is no "magic line" that separates exposed and non-exposed populations. This PHA evaluates exposures for locations within 5 miles of the TSCA Incinerator, with the understanding that the highest exposures occur in this area and that all exposures at locations further away are undoubtedly lower.

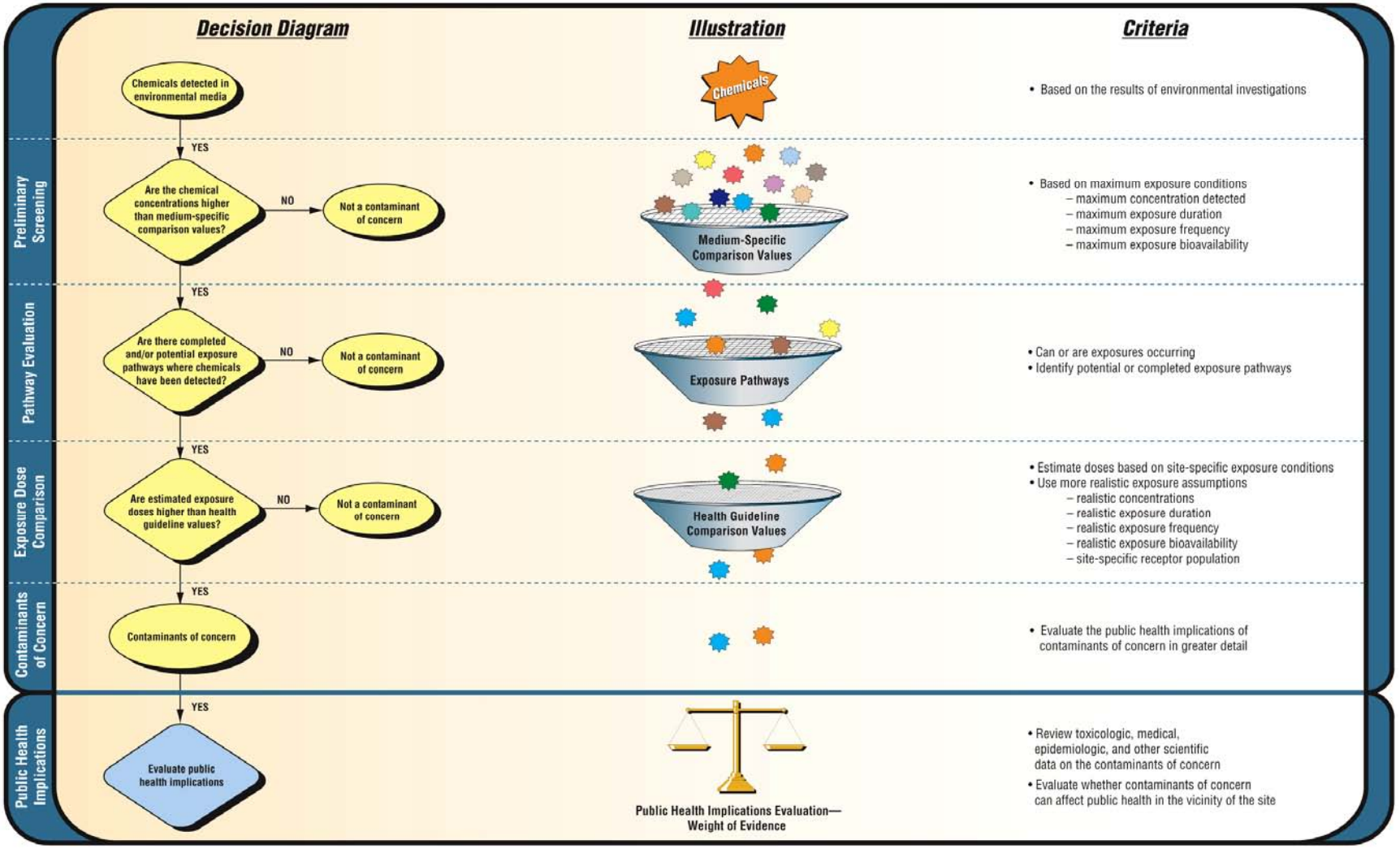
What: What contaminants does this PHA consider? The PHA examines exposures to contaminants that the TSCA Incinerator likely releases. Emissions from sources other than the TSCA Incinerator are considered in these evaluations, as appropriate, to provide perspective on exposures. Section III.B.1 identifies eight groups of contaminants that ATSDR considers in this PHA.

After establishing the scope of this evaluation, ATSDR used a screening process to identify the contaminants of potential health concern that warrant more detailed consideration (see Section IV). Figure 9 depicts this screening process, in which measured or estimated environmental contamination levels — in this case, ambient air concentrations and radiation levels — are compared with medium-specific comparison values. Comparison values (see definition in Appendix E) are developed from the scientific literature concerning exposure and health effects. To be protective of human health, most comparison values have safety factors built into them. For some contaminants, the safety factors are quite large (a factor of 100 or greater). As a result, contamination levels lower than their corresponding health-protective comparison values are generally considered to be safe and not expected to cause harmful health effects. In other words, these comparison values are generally (and intentionally) selected to be lower than the lowest

environmental concentrations known to be associated with adverse health effects, considering an ample margin of safety. But the opposite is not true: contamination levels greater than comparison values are not necessarily harmful. Rather, contaminants found above comparison values require a more detailed toxicologic or radiologic evaluation. In short, ATSDR uses health-protective comparison values to identify contaminants of potential health concern, which require more detailed evaluations (see Section IV) to assess the public health implications of exposure. Appendix D defines the specific comparison values used in this PHA.

The remainder of this section draws from emissions studies, air dispersion modeling studies, and ambient air monitoring or ambient air sampling studies to identify contaminants released by the TSCA Incinerator and to select contaminants of potential health concern. Section III.E summarizes the findings of this exposure pathway evaluation.

Figure 9. Process for Selecting Contaminants of Potential Health Concern



III.B. Emissions: What Contaminants Are Released to the Air?

Since 1991, DOE and other parties have compiled extensive information on the amounts of air pollutants that the TSCA Incinerator releases. This section reviews that information, both for stack emissions (Section III.B.2) and for fugitive emissions (Section III.B.3). As noted earlier in this PHA, stack emissions from the TSCA Incinerator are air releases through confined streams, specifically the main stack and the TRV. "Fugitive emissions" refers to all other releases, such as passive venting, wind-blown dust, and evaporative losses. Before reviewing information on stack and fugitive emissions, this section first identifies eight groups of contaminants that hazardous waste incinerators commonly release. The analyses throughout this PHA focus entirely on these groups of contaminants.

This section then reviews emissions data primarily to identify contaminants released from the incinerator. ATSDR typically does not base conclusions on emissions data alone — air emissions disperse considerably between their sources and the locations where people might be exposed. For this reason, ATSDR's environmental health conclusions are based on a combined assessment of emissions data, fate and transport studies, and ambient air monitoring and ambient air sampling studies.

III.B.1. Groups of Contaminants to Evaluate

Incinerators release many different contaminants into the air. These include typical combustion by-products, products of incomplete combustion, and incombustible materials in the waste stream. The emission rate of a given contaminant typically varies with time and depends on the composition of waste material being treated, the incinerator's operating parameters, and the effectiveness of air pollution controls. Multiple federal agencies have published review documents evaluating general public health issues for incineration facilities and identify contaminants that tend to be of greatest concern (ATSDR 2002; EPA 1998; NRC 2000). Using information in these review documents, ATSDR identified eight groups of contaminants to evaluate in this PHA. Table 6 identifies these groups, defines what contaminants fall into them, and explains how they relate to the TSCA Incinerator. The analyses that follow are organized around these contaminant groups.

Groups of contaminants ATSDR evaluated. This PHA evaluates the public health implications of exposure to the following eight groups of contaminants:

1. Particulate matter
2. Volatile organic compounds
3. Polychlorinated biphenyls
4. Metals
5. Acidic gases
6. Dioxins and furans
7. Polycyclic aromatic hydrocarbons
8. Radionuclides

Taken together, these groups include more than 500 individual contaminants. Refer to Table 6 for more information on these groups.

Table 6. Contaminant Groups Evaluated in this PHA

Group Name	*Contaminants within the Group*	*Relationship to Incineration Facilities*
Particulate matter	PM2.5, PM10, TSP	Virtually all combustion processes generate airborne particles and droplets. Air pollution controls at the TSCA Incinerator remove most particulate matter from the air exhaust, but some particulates are released.
VOCs	Numerous organic compounds with low molecular weight and high volatility	Waste feeds at the TSCA Incinerator, especially the liquid feeds, contain many VOCs. While the incineration process efficiently destroys most VOCs in the waste feed, trace amounts might pass through untreated. Incomplete combustion might generate trace amounts of other VOCs.
PCBs	209 individual chemicals, known as PCB congeners, that share a common chemical structure	PCBs are found in liquid and solid waste feeds to the TSCA Incinerator. Although the incinerator must destroy more than 99.9999% of the PCBs in these feeds, trace amounts might pass through the incinerator untreated. PCBs are not combustion by-products.
Metals	Numerous elements which, when pure, conduct heat and electricity and are generally hard and strong	Metals pass through incineration processes untreated., either into the residuals (e.g., ash) or into the air emissions. Though air pollution controls at the TSCA Incinerator remove considerable amounts of metals from the air exhaust, some metals from the waste feed do pass into the air untreated.
Acidic gases	Multiple inorganic compounds, such as hydrogen chloride and hydrogen fluoride	Acidic gases form in nearly all fuel and waste combustion processes, including incineration. The TSCA Incinerator's air pollution controls remove over 99% of hydrogen chloride in the process gas stream.
Dioxins and furans	210 individual chemicals, known as congeners, that share some common chemical structures	Dioxins and furans form in processes that burn mixtures containing both chlorine and organic material. Incinerator and air pollution control design can greatly reduce, but not eliminate, formation and release of dioxins and furans.
PAHs	Numerous organic compounds characterized by having multiple aromatic rings	The TSCA Incinerator likely destroys PAHs in the waste feed efficiently. Most PAHs in air emissions likely result from incomplete combustion of organic materials in the waste feeds.
Radionuclides	Unstable or radioactive forms of any element	The waste feed to the TSCA Incinerator contains radionuclides, which pass through the combustion chambers untreated. The radionuclides leave the facility either in residuals (e.g., ash) or in air emissions. Air pollution controls remove most radionuclides from the gas stream, but trace amounts do pass through the entire process and vent into the air.

Note: In this PHA, the term "dioxins" refers to the group of chemicals known as chlorinated dibenzo-p-dioxins, and "furans" refers to the group of chemicals known as chlorodibenzofurans. ATSDR notes that the TSCA Incinerator likely emits additional pollutants, such as trace amounts of additional semi-volatile organic compounds. However, the waste composition data that ATSDR reviewed (DOE 2003a) suggests that the quantities of these compounds emitted are likely immeasurably small.

III.B.2. Stack Emissions

Since 1988, DOE and its contractors have conducted numerous studies to measure both how efficiently the TSCA Incinerator destroys wastes and how much contamination the site releases into the air. The following discussion summarizes the available information on the TSCA Incinerator's emissions, first for routine releases through the main process stack and then for episodic releases through the TRV:

- **Routine releases through the main stack.** DOE and its contractors, under EPA and TDEC oversight, have measured emission rates from the TSCA Incinerator using three types of studies: trial burns, performance tests, and continuous emissions monitoring. Appendix A defines the different types of test and presents ATSDR's detailed reviews of the studies conducted to date.

  Table 7 summarizes key findings of the stack emissions tests and reveals two notable findings. First, the table shows that emission rates have been measured for all eight groups of contaminants that ATSDR is evaluating in this PHA. While some groups of contaminants have been studied more extensively than others, there are no notable data gaps in terms of the contaminants that have been considered. Second, the final column in Table 7 indicates that the measured emission rates generally met permitted limits, in cases where such limits have been established. As the exceptions, a small fraction of the measured emission rates for particulate matter have exceeded permitted limits, and some stack gas concentrations for semi-volatile metals (cadmium and lead) in 2000 and 2001 exceeded technology-based (i.e., not health-based) emissions standards that EPA would later establish in MACT standards. Fortunately, fairly extensive ambient air monitoring data are available for these contaminants. As Section III.D details, those ambient air monitoring data indicate that off-site airborne levels of particulate matter, cadmium, and lead have always been below levels of health concern, despite the fact that emission rates and stack gas concentrations have occasionally exceeded permitted limits or emissions standards.

Table 7. Emissions Data Available for the Groups of Contaminants

Contaminant Group	*Air Emission Rates Measured Using:*			*Overall Findings*
	Trial Burns	*Performance Tests*	*Continuous Sampling*	
Particulate matter	√	√	√	The overwhelming majority of tests, but not every test, have shown compliance with permitted limits for stack gas concentrations and emission rates. In addition, an extremely large volume of ambient air monitoring is available to support health conclusions on particulate matter (see Section III.D). Continuous emissions monitoring is about to begin.
VOCs	√			No permit limits are available for individual VOCs. Conclusions are based on dispersion modeling analyses (see Section III.C).
PCBs	√			Both trial burns showed that the incinerator's DRE for PCBs is higher than the required limit (99.9999%). Modeling estimates (see Section III.C) and monitoring data (see Section III.D) for PCBs were also considered.
Metals	√	√	√	All tests conducted since the incinerator began routine operations have shown compliance with health-protective *emissions* limits for beryllium, lead, and mercury. *Stack gas concentration* limits have consistently been met for mercury and low-volatile metals (arsenic, beryllium, and chromium). In 2000 and 2001, some stack gas concentrations for cadmium and lead exceeded limits that EPA would later establish in MACT standards. ATSDR used an extensive database of ambient air monitoring results to evaluate the metals further (see Section III.D, Appendix A.3).
Acidic gases	√	√		Every measured emission rate of hydrogen fluoride and hydrogen chloride to date has been at least an order of magnitude lower than the corresponding permitted emission limits.
Dioxins and furans	√			Stack gas concentrations of dioxins and furans have always been lower than levels set in the recent emissions standards. Ambient air monitoring data for dioxins and furans were also reviewed (see Section III.D).
PAHs	√			There are no permit limits for individual PAHs. Conclusions are based on dispersion modeling analyses (see Section III.C).
Radionuclides			√	There are no permit limits for individual radionuclides. Conclusions are based on dispersion modeling analyses (see Section III.C) and ambient air monitoring data (see Section III.D).

Notes: Refer to Appendix A for detailed reviews of the trial burns, performance tests, and continuous emissions monitoring at the TSCA Incinerator.

- **Episodic releases following TRV openings.** As Table 2 of this PHA notes, on 18 occasions between 1991 and 2004, the TRV at the TSCA Incinerator opened. These openings prevent high-temperature gases from damaging air pollution controls or harming employees, but they also result in afterburner gases briefly venting into the atmosphere without first passing through air pollution controls. Increased emissions during the TRV events are extremely short-lived.

  Emission rates have never been measured during times when the TRV is open. Measuring such emissions presents several logistical challenges. For instance, specialized equipment would be necessary to sample releases, given that afterburner gases would likely be at temperatures (>2,200 degrees Fahrenheit) that would damage conventional stack testing equipment. Further, field personnel who sample air in close proximity to such high-temperature gases face very serious health and safety issues. Finally, the short time scales of TRV releases present difficulties — many EPA stack testing methods require sampling of at least an hour's duration to get adequate sample volumes. For these reasons, ATSDR is not convinced of the feasibility of measuring emission rates when the TRV is open, especially considering that DOE already collects ambient air samples at upwind and downwind locations during these times. Refer to Section III.D for ATSDR's review of the ambient air sampling that has occurred during the TRV events.

Residents are not exposed directly to the incinerator's emissions. ATSDR reviews emissions data to better characterize what is released. Air monitoring data (see Section III.D) offer the best insights into airborne contamination levels that people might breathe.

In summary, DOE has extensively characterized routine emissions through the incinerator's main stack. In reaching health conclusions for the TSCA Incinerator, ATSDR considered the measured emission rates, along with findings from the fate and transport and ambient air monitoring studies. ATSDR does not view the absence of measured emission rates for TRV openings as a critical data gap, given the fact that air samples are collected during all TRV events and that the events occur so infrequently. (Note, not all samples collected during TRV events are currently analyzed.)

III.B.3. Fugitive Emissions

Measuring fugitive emission rates is inherently difficult, considering that industrial facilities' releases can occur from numerous locations. The exact amount of fugitive emissions from the TSCA Incinerator is not known, but two observations suggest that the amount is relatively low. First, DOE is required to implement a fugitive emissions monitoring program, in which periodic measurements of organic vapors are taken throughout the facility to ensure that process leaks and other fugitive emissions sources are identified and promptly controlled. Second, the following facility design features help minimize fugitive emissions:

- The entire incinerator operates under negative pressure, which helps prevent vapors and dusts from blowing out of the incineration process.
- Liquid wastes are handled in a manner that minimizes releases of untreated wastes. For instance, the wastes that arrive in tank trucks, are pumped into storage tanks in closed

systems. Further, all organic liquid storage tanks have vents equipped with carbon adsorption units that help prevent VOCs from evaporating directly into the atmosphere and prevent releases during tank loading operations. The carbon adsorption units have breakthrough indicators that give advance warning of when the units need to be changed. Facility personnel inspect the breakthrough indicators daily.

- All ash generated in the rotary kiln is discharged into water in the ash sump, which greatly reduces the amount of ash that might otherwise blow into the air.

Combined, these observations suggest that the fugitive emissions are minimal, though the exact amount of fugitive emissions remains unknown. The independent panel of experts chartered by the Governor of Tennessee reached a similar finding regarding the TSCA Incinerator's fugitive emissions (Iglar et al. 1998).

ATSDR does not view the lack of quantitative fugitive emissions data as a critical data gap — the extensive ambient air monitoring data and ambient air sampling data for this site (see Section III.D) characterize the air quality impacts from all local sources of emissions, including the fugitive emissions from the TSCA Incinerator.

III.C. Fate and Transport: How Do the Contaminants Move through the Air?

Dispersion models estimate air quality impacts from an emissions source based on a scientific understanding of how contamination moves through the air. The models can only estimate ambient air concentrations, and these estimates may understate or overstate actual air quality impacts. The accuracy of modeling outputs largely depends on the scientific rigor of the model itself and the quality and representativeness of model input parameters.

ATSDR identified two air dispersion modeling studies of the TSCA Incinerator's emissions. The independent panel chartered by the Governor of Tennessee conducted one study (Iglar et al. 1998) and DOE conducted the other (DOE 1997–2002). To address limitations in these studies, ATSDR conducted an additional modeling evaluation. Appendix B presents detailed reviews of these three modeling studies.

The independent panel's modeling study concludes that the incinerator's air quality impacts are greatest at locations southwest and northeast of the TSCA Incinerator. This finding is not surprising, given the prevailing wind patterns and local terrain features. The exact point of maximum impact was predicted to be 0.4 miles southwest of the stack, at a location within ETTP (Iglar et al. 1998). ATSDR used modeling results predicted at this on-site location to identify contaminants of concern. This approach is believed to be health-protective because the maximum air quality impacts found within ETTP are higher than the incinerator-related impacts that most residents experience, whether for short-term or long-term exposures.

Table 8 outlines key findings from the three modeling studies reviewed in this PHA. While detailed reviews of the individual studies are in Appendix B, several general observations should be noted. First, between the three modeling studies, all eight groups of contaminants of interest for the TSCA Incinerator were evaluated, leaving no notable data gaps. Second, with one exception addressed below, the modeling for every contaminant group found that estimated annual average ambient air concentrations were lower than health-based comparison values. In

the cases of particulate matter, most VOCs, PCBs, acidic gases, dioxins and furans, and PAHs, the estimated concentrations were all more than 100 times lower than the corresponding health-based comparison values. While ATSDR acknowledges that modeling analyses such as these have inherent uncertainties, these analyses appear to be scientifically sound and to offer reasonable accounts of the incinerator's air quality impacts (see Appendix B). Of course, no air dispersion model is perfect; for this reason, ATSDR carefully reviewed the extremely large volume of ambient air monitoring data (see Section III.D) for this site to assess the accuracy of the modeling estimates. Overall, the information in Table 8 suggests that the TSCA Incinerator's air emissions do not cause residents to be exposed to unhealthful levels of air contaminants, at least over the long term.

Three additional comments on the modeling analyses deserve mention. 1) all of the modeling studies considered for this PHA predicted ambient air concentrations representative of chronic exposures as a result of routine stack releases, and did not consider potential acute exposures nor non-routine releases through the TRV. ATSDR's review of ambient air sampling data during TRV events (see Section III.D) provides perspective on the acute exposure scenarios that appear to be of greatest concern. 2) the extensive ambient air monitoring data (see Section III.D) for many of the contaminants, especially particulate matter, metals, and radionuclides, compensates for any inherent uncertainties in the modeling analyses. 3) using the independent panel's modeling analysis, ATSDR selected chromium as a contaminant of concern. This selection was made due to the lack of information on the relative amounts of trivalent and hexavalent chromium in the ambient air. Section IV.C of this PHA revisits this issue.

Table 8. Fate and Transport Modeling Results Available for the Groups of Contaminants

Contaminant Group	*Modeling Evaluation Conducted by:*			*Overall Findings*
	Governor of Tennessee's Independent Panel	*DOE*	*ATSDR*	
Particulate matter	√			The estimated annual average concentration of particulate matter at the point of maximum impact was 0.067 µg/m^3 — considerably lower than both EPA's health-based air quality standards and the levels of airborne particulate matter routinely found in this part of the country.
VOCs	√		√	The TSCA Incinerator efficiently destroys VOCs. Even at the point of maximum impact, the estimated VOC concentrations were mostly three orders of magnitude below health-based comparison values.
PCBs	√		√	Modeling conducted by both the independent panel and ATSDR found that estimated ambient air concentrations of PCBs from routine operations are more than 1,000 times lower than health-based comparison values, even for the year when the greatest amount of PCBs was processed.
Metals	√			Chromium was selected as a contaminant of concern, but estimated air concentrations of all other metals were safely below health-based comparison values.
Acidic gases	√		√	Estimated ambient air concentrations of acidic gases are more than 400 times lower than their corresponding health-based comparison values.
Dioxins and furans			√	Estimated ambient air concentrations of dioxins and furans are immeasurably low, even at the point of maximum impact, where exposure concentrations are more than 100 times lower than health-based comparison values for cancer effects.
PAHs			√	ATSDR's modeling analysis of emissions data collected during a recent trial burn suggests that the highest annual average concentration of total PAHs (0.000005 µg/m^3) is far below levels of health concern, even if one conservatively assumed that only the most toxic PAH is present.
Radionuclides		√		DOE has estimated (using an EPA-approved model) that, in all years during which the TSCA Incinerator operated, air emissions of radionuclides from the entire ORR cause an effective dose equivalent to the maximally exposed resident of less than 1.7 mrem/year — a dose far below health-protective values established in EPA regulations. Extensive ambient air monitoring data are consistent with this estimated dose.

Notes: Appendix B reviews the three modeling evaluations listed above and identifies additional modeling studies that have been conducted.
Modeling addressed releases from routine operations. See Section III.D for ambient air sampling results during non-routine releases (i.e., TRV events).

III.D. Ambient Air Monitoring and Ambient Air Sampling: What Are the Levels of Air Contamination?

This section reviews the results of ambient air monitoring and ambient air sampling studies, or studies that measure contamination in the air that people breathe. Studies conducted by DOE, EPA, and TDEC weighed heavily in the conclusions ATSDR developed for this PHA. In response to a community concern, ATSDR also obtained and reviewed data compiled by TVA, but those data were not collected to assess air quality impacts from the TSCA Incinerator. Appendix C presents ATSDR's detailed reviews of the relevant ambient air monitoring and ambient air sampling studies.

Across all the studies conducted to date, an extremely large volume of ambient air monitoring and ambient air sampling data are available to characterize the TSCA Incinerator's air quality impacts. These data span the entire time frame during which the TSCA Incinerator has operated (1991 to the present), have been collected in locations believed to have the greatest air quality impacts, and have thoroughly characterized ambient air concentrations for multiple contaminant groups, especially particulate matter, metals, and radionuclides.

Terminology. In the field of air pollution, *ambient* air generally refers to outdoor air that people might breathe. Ambient air is commonly measured by equipment placed at a fixed outdoor location.
Ambient air monitoring differs from air sampling in that *monitoring* typically implies periodic measurement of air contamination levels. Monitoring provides useful insights on how air quality changes over the long term. Air *sampling*, on the other hand, generally refers to air quality measurements of discrete events, such as a TRV opening.

Both ambient air monitoring and ambient air sampling measure airborne contamination levels. But it is important to remember that measured concentrations reflect contributions from all nearby emissions sources and some distant ones. Thus, even though monitoring and sampling studies have been designed to characterize air quality impacts from the TSCA Incinerator, the air contamination levels measured do not necessarily originate only from the incinerator. ATSDR's interpretations throughout this section are sensitive to this issue. Nonetheless, the public health evaluations presented in this PHA are ultimately based on the measured air contamination levels that people might inhale, regardless of the source or sources believed to account for most of the contamination.

Table 9 gives an overview of the air quality measurements available for the eight groups of contaminants evaluated in this PHA. The remainder of this section provides more detailed summaries of the relevant air quality measurements collected both during routine operations at the TSCA Incinerator (see Section III.D.1) and during episodic releases, mainly TRV openings (see Section III.D.2). ATSDR used these measurements to characterize potential chronic and acute exposures to incinerator emissions.

Table 9. Ambient Air Monitoring and Ambient Air Sampling for the Groups of Contaminants

Contaminant Group	*Study Conducted by:*			*Overall Findings*
	DOE	*EPA*	*TDEC*	
Particulate matter	√			DOE has collected more than 2,000 particulate matter samples, both PM10 and TSP, at or near ETTP since the TSCA Incinerator first began operating. Every measured concentration and every annual average concentration has been well below EPA's corresponding health-based air quality standards.
VOCs				VOCs have not been measured in any studies at ETTP. However, air dispersion modeling studies estimated the incinerator's likely incremental impacts on airborne VOC levels: these air quality impacts were consistently more than 100 times lower than levels of public health concern.
PCBs	√			Routine PCB monitoring has not occurred, but DOE has measured PCB concentrations during TRV events, when emissions might be expected to peak. Even the highest total PCB concentration recorded during a TRV event (0.00082 $\mu g/m^3$) is well below health-based comparison values.
Metals	√		√	DOE has routinely monitored ambient air concentrations of metals since the TSCA Incinerator first processed wastes, and TDEC has conducted side-by-side monitoring to verify that DOE's monitoring results are valid. Combined, these measurements suggest that airborne levels of arsenic, cadmium, and chromium require more detailed evaluations. Section IV.B of this PHA assesses the public health implications of exposure to these contaminants.
Acidic gases				Although acidic gases have not been measured in any of the ambient air monitoring or ambient air sampling studies, estimated air concentrations of hydrogen chloride and hydrogen fluoride were both more than 400 times lower than levels of public health concern, even at the point of maximum air quality impacts.
Dioxins and furans	√			Like PCBs, dioxins and furans have not been monitored routinely near the TSCA Incinerator, but they have been measured during TRV events. The measurements did not find contamination to be at levels of health concern, especially considering the limited exposure durations for these events.
PAHs				Although PAHs have not been measured in any of the ambient air monitoring or ambient air sampling studies, ATSDR's air modeling study found incinerator-related air quality impacts from PAH emissions to be orders of magnitude below health-based comparison values.
Radionuclides	√	√	√	DOE, EPA, and TDEC have all conducted extensive monitoring near the TSCA Incinerator for ambient levels of radiation and radionuclides. This monitoring, which is continuous and has spanned almost the entire duration of TSCA Incinerator operations, has shown that concentrations of radionuclides are considerably lower than corresponding health-based comparison values.

Notes: Refer to Appendix C for detailed reviews of the ambient air monitoring and ambient air sampling results listed in this table.
Modeling addressed releases from routine operations. See Section III.D for ambient air sampling results during non-routine releases (i.e., TRV events).

III.D.1. Measurements During Routine Operations

The following paragraphs briefly review the results of the ambient air monitoring and air sampling that DOE, EPA, and TDEC have conducted during the TSCA Incinerator's routine operations. For three out of the eight groups of contaminants that ATSDR is evaluating, over the last 15 years an extremely large volume of air quality measurements have been made . While Appendix C describes detailed features of the individual monitoring efforts, the following paragraphs (and Table 9) highlight notable trends across the studies:

- **Particulate matter.** Between 1991 and the present, DOE has collected more than 2,000 valid 24-hour average particulate matter samples, both as PM10 and TSP. The samples were collected using appropriate methodologies and sampling schedules, and the measured concentrations appear to be of a known and high quality. The samples were collected at numerous locations around ETTP (see Figures C-1 and C-2), including locations where dispersion models predicted maximum ground-level impacts from the TSCA Incinerator. Every single 24-hour average PM10 and TSP concentration measured to date has been below EPA's corresponding health-based air quality standards, and the annual average concentrations calculated from these individual measurements have also been below appropriate health-based standards. Additionally, the sampling data did not reveal any pronounced spatial variations in particulate matter concentrations. In short, DOE has compiled an extremely extensive data set on particulate matter over the entire history of the TSCA Incinerator's operations, and the measured PM10 and TSP concentrations have not reached levels of health concern.

- **Metals.** As Appendix C describes in greater detail, both DOE and TDEC have measured ambient air concentrations of metals at multiple locations around the TSCA Incinerator. DOE has taken samples at regulator intervals for airborne metals since the TSCA Incinerator first operated, and TDEC has done so for the last 7 years. Both parties' sampling considered the same set of seven metals. Of these, beryllium, lead, nickel, and uranium had no concentrations greater than health-based comparison values. On the other hand, arsenic, cadmium, and chromium all had annual average concentrations greater than health-based comparison values (using a comparison value for hexavalent chromium to screen the chromium concentrations). The measured levels for these three metals did not exhibit notable spatial variations across the monitoring stations, suggesting that no single emissions source contributes most to these metals' ambient air concentrations. Nonetheless, ATSDR selected arsenic, cadmium, and chromium as requiring further evaluation. Section IV evaluates the public health implications of exposure to these metals in greater detail.

  When reviewing air quality measurements for metals, ATSDR identified several opportunities for improving and enhancing the existing ambient air sampling networks. First, ATSDR noted that a stated purpose of TDEC's program is "to provide an independent verification of monitoring results as reported by the DOE" (TDEC 1996–2002). ATSDR agrees that this is an important objective. Given that DOE and TDEC now operate metals sampling equipment at the same locations, TDEC should be able to perform a quantitative verification of the sampling results, consistent with the program goals. But no detailed data comparisons were documented in the site reports that ATSDR reviewed. Recognizing that independent co-located measures of the same air contaminants provide an excellent

opportunity for verifying the quality of DOE's metals data, ATSDR has recommended that TDEC conduct such an analysis and document findings in a future annual environmental report (see Section IX).

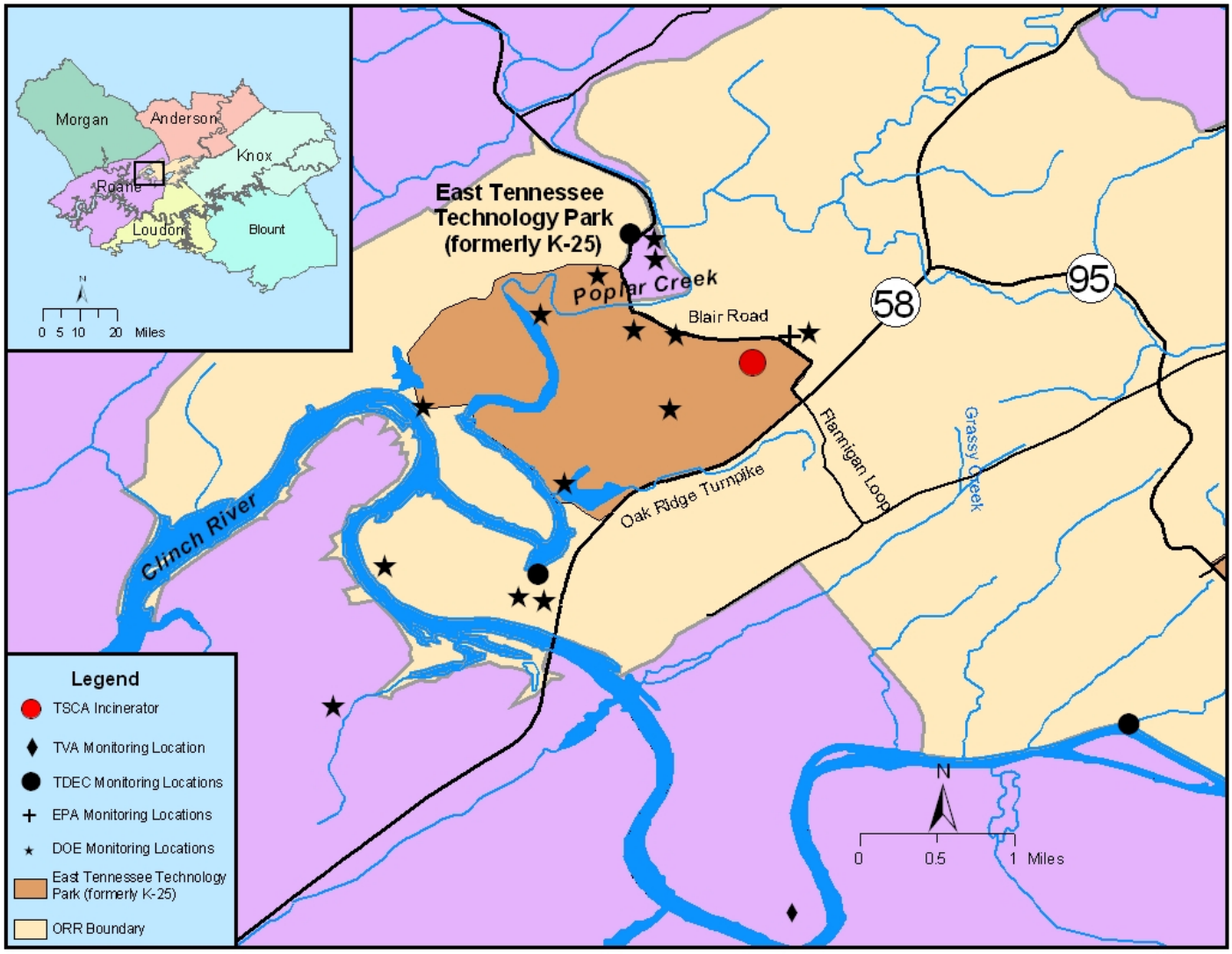
ATSDR was prepared to conduct its own comparison of DOE's and TDEC's ambient air sampling data for metals, but could not do so due to how the two agencies' annual environmental reports present metals data. Although general trends in the two data sets appear to be consistent, a quantitative comparison is impossible because the annual reports do not document detection limits and sometimes aggregate data from multiple stations into area-wide averages. Because these and other reporting practices limit the utility of the measurement results, ATSDR has recommended several improvements to the data presentation in DOE's and TDEC's annual environmental sampling reports. Section IX of this PHA lists these recommendations.

Some data trends illustrate potential conflicts between data reported by DOE and TDEC. In DOE's sampling, both arsenic and cadmium apparently were detected in an overwhelming majority of air samples. In TDEC's sampling, on the other hand, these metals appear to have been detected infrequently. This apparent conflict is best explained by the use of analytical methods with differing sensitivities. TDEC currently uses an analytical method with detection limits ranging from 0.001 to 0.01 $\mu g/m^3$, while the method DOE uses achieves much lower detection limits. ATSDR has recommended that TDEC independently verify the accuracy of DOE's metals data, whether through using more sensitive analytical methods or through other means.

- **Radionuclides.** From at least 1991 to the present, DOE's environmental surveillance network has included perimeter sampling at the main ORR facilities. At ETTP, for instance, DOE has operated two perimeter sampling stations to measure airborne concentrations of radionuclides in air masses before they blow into nearby communities. DOE's program has considered numerous gamma-emitting radionuclides, including those found to account for the highest portion of the effective dose equivalent at off-site receptors attributed to the TSCA Incinerator's air emissions (see Appendix B.2). The radionuclides reported most frequently were isotopes of beryllium, cesium, cobalt, potassium, thorium, and uranium. As Appendix C.1 documents in detail, DOE's ambient air sampling program never detected these and other radionuclides at levels greater than health-based comparison values (i.e., DOE's derived concentration guides). More importantly, even the highest annual average concentration measured was more than 100 times lower than levels of potential health concern.

  In addition to DOE's sampling efforts, TDEC has collected air samples at regular intervals for radionuclides at ETTP (see Appendix C.3), but this sampling did not commence until 1996. The samples that TDEC collected were all analyzed by an EPA laboratory. The sampling device is installed at DOE's K-2 station (see Figure 10), approximately ¾-mile from one of DOE's perimeter monitoring stations. As the text box below indicates, there is reasonable agreement between DOE's and EPA's measurements for uranium isotopes, especially considering that the sampling devices are not co-located. Also encouraging is the fact that both networks reported a similar relative abundance across the different uranium isotopes.

Figure 10. Locations of Ambient Air Monitoring and Ambient Air Sampling Stations



Overall, both DOE and EPA have reported extensive sampling results for airborne radionuclides at locations downwind from the TSCA Incinerator. Both sets of sampling results show that exposures to airborne radionuclides, even at the location believed to be most impacted by incinerator emissions, are well below levels of potential health concern. Also significant is the fact that the independent data measures are reasonably consistent, which suggests (but does not prove) that neither set suffers from serious data quality problems.

In summary, ambient air monitoring data and air sampling data for particulate matter, metals, and radionuclides have been collected in multiple locations around ETTP over the entire history of the TSCA Incinerator's routine operations. While the available data do not characterize all eight contaminant groups considered in this PHA, they do quantify air quality impacts for three groups of contaminants that incinerators cannot destroy. Section III.E describes how ATSDR factored trends and patterns among these data into the overall air exposure pathway evaluation.

III.D.2. Measurements During Episodic Releases

The chief episodic releases of concern for the TSCA Incinerator are those that occur during TRV events — gases that have passed through the afterburner are vented directly to the atmosphere without first passing through air pollution controls. It is important to note, however, that the waste feed to the TSCA Incinerator immediately shuts down when TRV events occur, thus the increased emissions are short-lived therefore minimizing the potential air quality impacts during these episodes. It should be noted that the extent to which emission rates increase during TRV events vary greatly from one pollutant to the next. On the one hand, mercury emissions are basically the same during routine operations and during TRV events, given the limited ability of the air pollution controls to remove this contaminant. On the other hand, emission rates for pollutants efficiently collected by air pollution controls (e.g., hydrochloric acid) will increase substantially for short periods of time. The effects of TRV events on emissions for other pollutants fall between these two extremes.

As Table 2 indicates, 18 TRV events occurred between 1991 and 2004, and DOE collected and analyzed valid air samples at two locations during 9 of these events. The sampling locations are located southwest and northeast of the TSCA Incinerator, and therefore lie in the path of the prevailing winds. In fact, the two sampling locations lie in between the TSCA Incinerator and the nearest off-site residents; thus, measurements at these locations likely provide an upper-bound estimate of short-term exposure concentrations that residents might have experienced during TRV events. Currently, DOE evaluates the circumstances surrounding each TRV event to determine whether off-site ambient air samples should be analyzed. For instance, DOE could judge that analyzing samples is not necessary if a TRV event occurs when small quantities of wastes are being processed or if a previous sampling event already characterized the anticipated air quality impacts. Following is a summary of the monitoring data that have been collected to date:

- **PCBs.** The highest ambient air concentration of total PCBs measured during a TRV event was 0.000817 $\mu g/m^3$. This concentration was measured on June 18, 1995, when a power outage shut down the incinerator operations. This concentration is more than 10 times lower than the most protective health-based comparison value. Therefore, ATSDR concludes that exposure to even the highest PCB concentration measured during TRV events would not cause adverse health effects, especially considering the limited duration of exposure.

- **Dioxins and furans.** The highest ambient air concentrations of total dioxins and total furans measured during TRV events were 0.00000223 $\mu g/m^3$ and 0.00000593 $\mu g/m^3$, respectively. Evaluating these exposure concentrations is complicated — no health-based comparison values have been published for "total dioxins" or "total furans."

  As an alternate approach to assessing these concentrations, ATSDR compared the highest measured values to the range of background concentrations reported for the ETTP area (DOE 2003b). According to sampling that occurred while the TSCA Incinerator was down, background total dioxin levels near ETTP range from 0.000000774 to 0.00000416 $\mu g/m^3$, and the highest measured dioxin concentration during a TRV event falls within this range. ATSDR notes that the range of background concentrations reported for ETTP is reasonably consistent with ranges of background concentrations that have been reported for other parts of the country (ATSDR 1998). Therefore, even the highest dioxin concentration measured

during a TRV event does not appear to be unusually elevated. Given this observation and the extremely short exposure duration, ATSDR believes that the measured concentrations are not at levels of health concern and do not warrant further evaluation.

For total furans, the highest measured concentration during a TRV event is actually three times greater than the upper bound of the background measurements made at ETTP (DOE 2003b), but furan levels during the other TRV events were generally consistent with background levels. After review of an evaluation of the highest likely acute exposures, ATSDR does not view this lone detection above background levels as being of public health concern. Although very limited information is available on health effects in humans or animals after inhalation exposure to furans (ATSDR 1994), ATSDR has published a minimal risk level (MRL) for acute ingestion exposures to a potent furan congener. The acute ingestion MRL is 0.001 µg/kg/day. By definition (see Appendix D), this MRL is an ingestion dose likely without an appreciable risk for adverse non-cancer effects following a short-term exposure. For a typical adult (who weighs 70 kg), this acute MRL would represent an approximate ingestion intake of 0.07 µg/day. During the TRV openings, however, the highest likely inhalation intake is approximately 0.000047 µg/day.2 Therefore, the highest inhalation intake that an individual might have reasonably experienced during TRV openings is nearly 500 times lower than the ingestion intake associated with the acute ingestion MRL. This large margin provides some confidence that acute furan exposures during TRV openings are not associated with adverse health effects. As Section IX of this PHA notes, ATSDR recommends that DOE continue to collect ambient air samples during TRV openings to ensure that these events do not cause residents to be exposed to harmful levels of air pollutants.

- **Radionuclides.** As noted previously, DOE and EPA have radionuclide monitoring stations downwind of the TSCA Incinerator that continuously sample air. Although this sampling cannot quantify the short-term incremental air quality impacts associated with TRV events, releases during these events are accounted for in the long-term average measurements. Therefore, the monitoring data for radionuclides outlined in the previous section implicitly account for contamination released during the infrequent TRV events.

In summary, DOE has analyzed ambient air samples during half of the TRV events that occurred between 1991 and 2004. These data suggest that ambient air concentrations of PCBs, dioxins, and furans are not unusually elevated following these events, especially when compared to background levels. This observation, combined with the infrequent nature of the events and their short duration, implies that air quality impacts for these pollutants during TRV openings are negligible.

When preparing this PHA, ATSDR considered the need for DOE to analyze a greater fraction of the ambient air samples collected during the TRV events. The conclusion regarding TRV events would change only if the ambient air concentrations of dioxins, furans, and PCBs were consistently and dramatically higher than those that have been measured to date. ATSDR has no reason to expect that such elevated concentrations will occur, but a sensible way of assessing this

2 This intake was calculated by multiplying the highest furan concentration (0.00000416 µg/m^3) by an inhalation rate for adults engaged in heavy activities (3.2 m^3/hour, from EPA 1997) and by an estimated exposure duration (8 hours). These assumptions likely represent the highest possible exposures during a TRV opening.

is to analyze only those samples collected during TRV events associated with high waste feed rates or PCB inputs. In other words, the criteria that DOE currently uses when deciding whether to analyze samples should provide sufficient insights on whether air quality impacts during TRV events are unusually higher than the concentrations that have been measured to date. Based on this analysis, ATSDR is not recommending any change to the current ambient air sampling and analysis framework for TRV events.

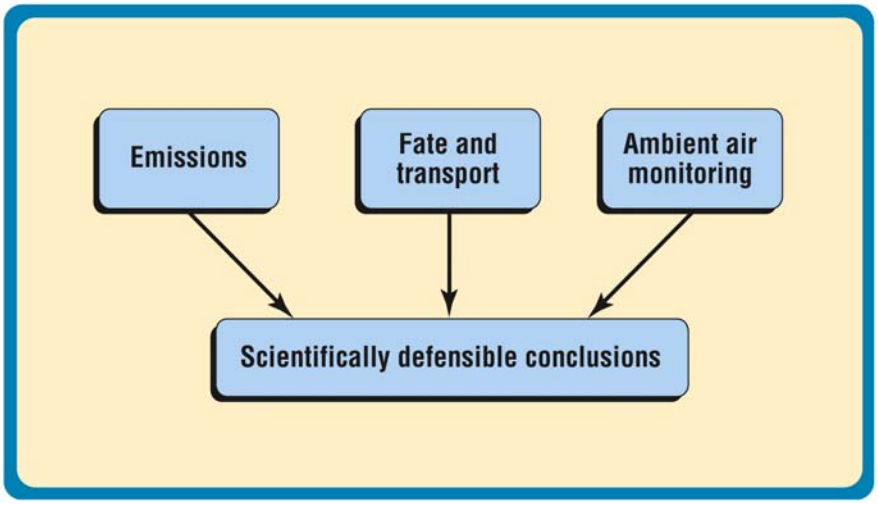
While there is limited evidence of short-term air quality impacts during these events based on the groups of contaminants measured, ATSDR acknowledges that it is possible for some groups of contaminants (namely acidic gases) to have substantially increased emissions during TRV events. As one example, the air pollution control efficiencies for hydrochloric acid suggest that air emissions during TRV events might be approximately 1,000 times greater than emissions during routine operations (see Comment #40 in Appendix G). Based on this observation, ATSDR has estimated that short-term ambient air concentrations of hydrochloric acid nearest the incinerator might reach levels of approximately 600 $\mu g/m^3$.3 Human exposure studies suggest that this upper-bound estimate of short-term exposure, while elevated, is not expected to be associated with adverse health effects. Specifically, a controlled exposure study found that human asthmatics exposed to hydrochloric acid at concentrations up to 2,700 $\mu g/m^3$ for 45 minutes did not experience any respiratory effects as gauged by multiple pulmonary function tests (Stevens et al. 1992). Considering that asthmatics did not develop respiratory symptoms when exposed to 2,700 $\mu g/m^3$ of hydrogen chloride, it is unlikely that any residents would experience adverse health effects should off-site ambient air concentrations of hydrochloric acid near the TSCA Incinerator ever reach 600 $\mu g/m^3$ during a TRV event.

III.E. Synthesis of Information

This entire section has focused on evaluating three critical elements of the air exposure pathway: emissions, fate and transport, and ambient air monitoring. One must consider all three elements in order to have a complete understanding of the air quality issues surrounding the TSCA Incinerator (see Figure 11).

3 ATSDR computed this estimate as follows: Appendix B.3 reports the estimated highest annual average concentration of hydrochloric acid to be 0.047 $\mu g/m^3$, based on modeling studies. Based on this annual average estimate, a reasonable estimate of maximum 1-hour average concentrations is approximately 12 times greater (EPA 1992), or 0.6 $\mu g/m^3$. If emissions during a TRV event are up to 1,000 times greater, then the estimated ambient air concentration would increase by the same factor, or could possibly reach 600 $\mu g/m^3$.

Figure 11. Synthesizing Information for the Air Exposure Pathway



The following discussion integrates the information presented above in an attempt to answer key questions: Is there enough information on the contaminant group to reach conclusions? Is the information in the available studies consistent? Are more detailed analyses required for any contaminants? Is further sampling needed for any of the contaminants? ATSDR's evaluation of these issues for the eight groups of contaminants follows:

- **Particulate matter.** More than 2,000 air samples for particulate matter have been collected at multiple locations around ETTP over the entire history that the TSCA Incinerator has operated. All of the sampling results are safely below EPA's corresponding health-based air quality standards. Consistent with these data are findings from the independent panel's modeling analysis, which predicted that the incinerator's particulate emissions would have limited air quality impacts at downwind locations. Further, nearly every stack test and trial burn conducted to date has found particulate matter emissions at levels below limits set in environmental permits. All these observations provide compelling evidence that the TSCA Incinerator does not emit particulate matter at levels expected to cause adverse health effects among residents.

- **VOCs.** During the RCRA trial burns, DOE demonstrated that the TSCA Incinerator destroys more than 99.99% of organic compounds in the waste feed. Further, continuous emissions monitoring for carbon monoxide and carbon dioxide provides a real-time indicator of how efficiently the incinerator is burning wastes. To evaluate potential air contamination levels, both the independent panel chartered by the Governor of Tennessee and ATSDR estimated VOC air concentrations using modeling techniques. Both modeling studies concluded that none of the VOCs released by the TSCA Incinerator are likely to ever exceed health-based comparison values. While ATSDR acknowledges that the modeling analysis has inherent uncertainty, the estimated concentrations for every VOC considered were more than 1,000 times lower than health-based comparison values. This ample "margin of safety" provides ATSDR some reassurance that small modeling uncertainties do not have a significant bearing

on the conclusion that the incinerator's emissions of VOCs are not at levels of health concern.

- **PCBs.** Every TSCA trial burn conducted to date has demonstrated that the incinerator destroys more than 99.9999% of the PCBs in the waste feed. Thus, for every 1,000,000 pounds of PCBs fed to the incinerator, less than 1 pound of PCBs is released to the air, assuming that the TSCA Incinerator consistently achieved the required DRE. For insights into potential air quality impacts, the independent panel's modeling study predicted that the maximum annual average PCB concentration at ETTP would be 0.000003 $\mu g/m^3$, which is more than 3,000 times lower than the most protective health-based comparison value. Given this large margin, ATSDR is confident in concluding that PCB exposures are not of public health concern. The sampling data collected during TRV openings provides further evidence that the incinerator's PCB emissions do not cause significant air quality impacts at off-site locations.

- **Metals.** Incinerators cannot destroy metals. Any metals fed to incinerators will either be released to the air or captured in process residuals (e.g., ash, sludge, wastewater). Both DOE and TDEC have conducted extensive ambient air monitoring for metals, which has more than adequate spatial and temporal coverage for reaching public health conclusions. Trends among the data suggest that ambient air concentrations of arsenic, cadmium, and chromium warrant further evaluation, while concentrations of beryllium, lead, nickel, and uranium are safely below health-based comparison values. These findings are reasonably consistent with the independent panel's modeling results. Refer to Section IV for ATSDR's evaluation of exposures to metals and to Section IX for suggested improvements to the metals sampling in the existing ambient air monitoring networks.

- **Acidic gases.** Ambient air concentrations of acidic gases have never been measured in the vicinity of the TSCA Incinerator. However, every measured emission rate of hydrogen fluoride and hydrogen chloride to date has been at least an order of magnitude lower than the corresponding permitted emission limits. Further, the highest concentrations of acidic gases (hydrogen chloride and hydrogen fluoride) estimated in ATSDR's modeling evaluation were more than 400 times lower than the chemicals' corresponding lowest health-based comparison values. ATSDR believes these observations sufficiently support the conclusion that the TSCA Incinerator does not release acidic gases at levels expected to harm off-site residents.

- **Dioxins and furans.** To date, all measured emission rates for dioxins at the TSCA Incinerator have met limits set in environmental permits and regulations. ATSDR evaluated potential air quality impacts in a modeling evaluation that considered the highest dioxin emission rate during a recent trial burn. This modeling estimated an annual average dioxin concentration at the point of maximum ground-level impacts, which lies within ETTP property, to be 3.75×10^{-10} $\mu g/m^3$ (on a TEQ basis). This estimated concentration, besides being immeasurably small and likely impossible to differentiate from background levels, is more than 100 times lower than the risk-based concentration of the most toxic dioxin congener. The dioxin levels measured during TRV events are also indistinguishable from background. For these reasons, ATSDR concludes that the air emissions of dioxins need not be evaluated further in this PHA.

- **PAHs.** ATSDR's modeling evaluation provides the best available information on potential exposures to PAHs from the TSCA Incinerator. Using PAH emission rates measured during a recent trial burn and a dispersion factor reported by the Governor of Tennessee's independent panel, ATSDR estimated that the incinerator's air emissions could cause annual average ambient air concentrations of total PAHs to increase by 0.000005 $\mu g/m^3$. Even if one assumes that the total PAHs consist entirely of the most potent individual compound, the estimated increase in concentration is more than 150 times lower than the corresponding risk-based concentration. ATSDR believes this information is a sufficient basis for conclusions for three reasons: 1) the emission rate used in the modeling analysis is expected to overstate air quality impacts, because it was measured during a trial burn that challenged the incinerator with the maximum allowed waste feed rate; 2) the estimated air concentration occurs at a location within the ETTP property, and off-site concentrations would be expected to be lower; and 3) an ample margin of safety separates the estimated concentration from the health-based comparison value.

- **Radionuclides.** Like metals, radionuclides pass through incinerators untreated. Most are captured in process residuals, but some are released to the air. To characterize the impacts of these releases, DOE has been collecting ambient air samples at regular frequencies for radionuclides at the ETTP perimeter since the TSCA Incinerator began operating. To date, the highest annual average concentrations for every radionuclide measured are more than 100 times lower than DOE's health-protective derived concentration guides (see Table C-3). Additionally, for the last 8 years, TDEC has collected air samples for radionuclides at a point directly downwind from the TSCA Incinerator. These samples were then forwarded to an EPA laboratory for analysis. EPA's measured concentrations are very consistent with DOE's, providing greater confidence that both programs are generating high-quality data. These trends, combined with extensive radiation dose modeling DOE conducts in fulfillment of regulatory requirements (i.e., NESHAPs), strongly suggest that the TSCA Incinerator's air emissions do not cause unsafe exposures to radiation or radionuclides. Given that incinerators do not destroy radionuclides (and the level of community concern regarding potential exposures), ATSDR has recommended, as a prudent public health measure, that DOE and EPA continue their ambient air sampling efforts for radionuclides into the future.

Referring to the previous discussion, ATSDR concludes that further analyses are needed to evaluate the public health implications of exposures to arsenic, cadmium, and chromium. For all other metals and groups of contaminants, the studies that have characterized emissions, fate and transport, and ambient air monitoring clearly show that the TSCA Incinerator's air emissions do not cause residents to be exposed to unhealthful levels of air contaminants.

IV. Public Health Implications

The previous section of the PHA used a screening analysis to select contaminants of concern for the TSCA Incinerator. In the screening, ATSDR compared the highest measured or estimated ambient air concentrations for all eight groups of contaminants with deliberately conservative health-based comparison values. Through that process, arsenic, cadmium, and chromium were found to warrant further evaluation, and all other air contaminants considered were safely below levels of public health concern. This section presents a more detailed analysis for the three contaminants requiring further evaluation, considering issues such as background concentrations, potential air quality impacts due to emissions from the TSCA Incinerator, and toxicological evaluations for both short-term (acute) and long-term (chronic) exposures and for both non-cancer and cancer health outcomes.

Residents near the TSCA Incinerator are exposed to airborne arsenic, cadmium, and chromium that originate from several nearby emissions sources. Extensive ambient air monitoring data suggest that the amounts of these metals in the air are below levels expected to cause adverse health effects. Ongoing monitoring will help ensure that ambient air concentrations of these metals remain at safe levels in the future.

In Sections IV.A, IV.B, and IV.C, the "toxicological evaluation" bulleted items first address potential non-cancer health outcomes, immediately followed by a separate evaluation for cancer health outcomes. It is appropriate to separate these evaluations due to the different approaches used to address public health implications. Additionally, sub-headers for "non-cancer evaluation" and "cancer evaluation" have been added to emphasize that the evaluations are indeed separate.

The remainder of this section presents ATSDR's detailed evaluations for arsenic (Section IV.A), cadmium (Section IV.B), and chromium (Section IV.C). Concluding statements (Section IV.D) discuss the adequacy of the data supporting ATSDR's evaluations and present recommendations for ensuring that inhalation exposures to the contaminants of concern remain at safe levels in the future.

IV.A. Arsenic

ATSDR selected arsenic as a contaminant requiring further evaluation because the highest annual average concentration of arsenic measured near ETTP (0.000809 $\mu g/m^3$) was approximately four times greater than a highly protective health-based comparison value for cancer effects (0.0002 $\mu g/m^3$) — this comparison does not mean that the measured arsenic concentrations are harmful or are even caused largely by the incinerator's emissions. Rather, the initial comparison simply means that further evaluation is needed to assess the public health implications of exposure, regardless of the origin of the airborne arsenic. To put potential inhalation exposures to arsenic into perspective, ATSDR considered the following observations:

- **Consistency with modeling results.** As Appendix B notes, the independent panel chartered by the Governor of Tennessee conducted a dispersion modeling analysis of the TSCA Incinerator's emissions. That analysis estimated that the incinerator's emissions alone contribute 0.000148 $\mu g/m^3$ to annual average concentrations at the point of maximum impact.

This estimated concentration is more than five times lower than the highest annual average concentration measured in the area. There can be many reasons why modeling and monitoring results differ. For instance, the difference might simply reflect uncertainties associated with the modeling analysis. However, given that the modeling was conducted in a manner that likely overstates air quality impacts (see Appendix B), a logical explanation for the difference is that contributions from other air emissions sources account for the difference between the measured concentrations and the modeled concentrations.

- **Comparison with typical airborne arsenic levels.** ATSDR's Toxicological Profile for Arsenic reports that average air concentrations of arsenic in remote areas of the United States typically range from <0.001 to 0.003 μg/m^3 (ATSDR 2000a). The measured arsenic levels near the TSCA Incinerator are at the lower end of this range. ATSDR makes this comparison only to demonstrate that residents near ETTP are not exposed to unusually high amounts of airborne arsenic.

- **Toxicological evaluation.** ATSDR's toxicological evaluation considers the public health implications of exposure to the measured concentrations of airborne arsenic, regardless of where it originated.

  Non-cancer evaluation. According to a literature review of numerous studies of arsenic exposure in humans and experimental animals, the lowest found exposure concentration that has been associated with non-cancer adverse health effects is 0.7 μg/m^3 (ATSDR 2000a). Specifically, a case-control epidemiological study among residents near a smelter found that exposures at this level were associated with a greater risk for stillbirths, compared with the risk for residents in a non-exposed group (Ihrig et al. 1998). ATSDR notes, however, that the highest annual average concentration of arsenic measured near the TSCA Incinerator is more than 850 times lower than the exposure concentration that might be associated with increased stillbirths. Because the measured airborne levels of arsenic are dramatically lower than exposure concentrations found to be associated with non-cancer health effects in humans and experimental animals, ATSDR concludes that inhalation of airborne arsenic near ETTP is not expected to cause similar non-cancer effects among local residents.

  Cancer evaluation. The National Toxicology Program (NTP), part of the U.S. Department of Health and Human Services, has classified arsenic as a "known human carcinogen." Accordingly, ATSDR assessed whether exposure to airborne arsenic near the TSCA Incinerator might be associated with cancer outcomes. Such assessments typically consider long-term exposure concentrations. In this case, the highest long-term average ambient air concentration of arsenic measured near ETTP is 0.0004 μg/m^3 — an average based on nearly 10 years of monitoring at a location immediately downwind from the site. In contrast, ATSDR's review of the literature has reported arsenic-related cancer effect levels in humans

What is a "cancer effect level"? ATSDR defines a cancer effect level as the lowest exposure dose in a study, or group of studies, that produces significant increases in the incidence of cancer between the exposed population and its appropriate control population.

What is a "lowest observed adverse effects level" (LOAEL)? ATSDR defines a LOAEL as the lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.

ranging from 50 to 380 μg/m^3 (ATSDR 2000a). Therefore, the highest annual average exposure concentration measured near the TSCA Incinerator is more than 100,000 times lower than the cancer effect levels reported in six different studies of human exposures. Given this large margin, ATSDR does not believe the measured concentrations of arsenic pose a significant health concern for cancer outcomes.

In summary, modeling studies predict that the TSCA Incinerator has little impact on ambient air concentrations of arsenic. This observation is consistent with the fact that measured airborne arsenic levels near the TSCA Incinerator fall within the range of concentrations measured in other remote locations of the United States. Using both these observations and a review of the toxicological and epidemiological literature, ATSDR concludes that inhalation exposures to airborne arsenic near the TSCA Incinerator are not expected to cause adverse health effects. Refer to Section IV.D for recommended actions to ensure that future exposures to arsenic near the TSCA Incinerator remain at safe levels.

IV.B. Cadmium

ATSDR selected cadmium as a contaminant requiring further evaluation — the highest annual average concentration of cadmium measured in the vicinity of ETTP (0.001963 μg/m^3) was approximately three times greater than the corresponding health-based comparison value for cancer effects (0.0006 μg/m^3) — this comparison does not mean that the measured cadmium levels are harmful or are even caused largely by the incinerator's emissions. Rather, the initial comparison simply means that further evaluation is needed to assess the public health implications of exposure, regardless of the origin of the airborne cadmium. After evaluating all information available on airborne cadmium near the incinerator, ATSDR made the following observations:

- **Consistency with modeling results.** The highest measured annual average concentration of cadmium (0.001963 μg/m^3) was 15 times greater than the peak ground level impacts (0.000129 μg/m^3) predicted by air dispersion modeling conducted by the Governor of Tennessee's independent panel. While the exact reasons for this discrepancy are not known, a reasonable explanation is that airborne levels of cadmium near the incinerator originate from many different sources, while the dispersion modeling analysis only considered the incinerator's air quality impacts. The considerable margin between the measured and modeled results is likely not explained by uncertainties in the modeling alone.

- **Comparison with typical airborne cadmium levels.** Ambient air concentrations of cadmium have been measured at two locations near the TSCA Incinerator (see K2 and K6 in Figure C-3) from 1994 to the present — almost the entire history of the incinerator's operations. Over this entire time frame, the average concentrations at these locations were 0.00044 μg/m^3 and 0.00033 μg/m^3, respectively, both of which fall below the lower bound of the range of average cadmium levels typically observed in urban areas across the country (0.003–0.040 μg/m^3) (ATSDR 1999a). ATSDR acknowledges that the general consistency between cadmium levels near ETTP and those measured in other parts of the country does not mean that the contamination levels near the TSCA Incinerator are safe or acceptable. Rather, ATSDR presents this information primarily for perspective, to indicate that local residents are not being exposed to unusually high amounts of cadmium.

- **Toxicological evaluation.** ATSDR's toxicological evaluation considers both non-cancer and cancer outcomes associated with inhalation exposure to airborne cadmium.

  Non-cancer evaluation. To evaluate non-cancer outcomes, ATSDR compared the measured concentrations near the TSCA Incinerator with exposure levels that have been shown to cause, or are suspected of causing, adverse health effects, whether in human or in experimental animals. More than 30 available peer-reviewed studies provide quantitative data related to inhalation toxicity of cadmium (ATSDR 1999a). Overall, the lowest concentration reported to produce non-cancer health effects, whether from acute or chronic exposure, is 13 $\mu g/m^3$ — an exposure concentration that caused increased non-cancerous cell growth in the lungs of experimental animals (ATSDR 1999a). All measured ambient air concentrations of cadmium near the TSCA Incinerator are at least 1,000 times lower than this level, which suggests that residents' inhalation exposures near ETTP are not at levels expected to cause non-cancer health effects. ATSDR acknowledges that using effects levels observed in animals to evaluate human exposures involves considerable uncertainty. It should be noted, however, that the lowest exposure concentration of cadmium shown to cause adverse non-cancer outcomes in humans (23 $\mu g/m^3$) is on the same order of magnitude as that shown to cause adverse outcomes in animals.

  Cancer evaluation. ATSDR also evaluated potential cancer outcomes associated with cadmium exposures, considering that NTP has classified cadmium as a "known human carcinogen." When evaluating potential cancer risks, ATSDR usually assesses potential lifetime average exposure levels. The highest long-term average ambient air concentration of cadmium near ETTP is 0.000044 $\mu g/m^3$, which is based on nearly 10 consecutive years of monitoring data collected at a location immediate downwind of the TSCA Incinerator. ATSDR's review of carcinogenic outcomes associated with cadmium found cancer effect levels in animals and humans ranging from 13.4 to 100 $\mu g/m^3$ (ATSDR 1999a). In this case, the cadmium exposures near the TSCA Incinerator are more than 300,000 times lower than the lowest cancer effect level derived from the literature. Accordingly, ATSDR concludes that the TSCA Incinerator's emissions do not result in nearby residents' exposure to cadmium at levels associated with cancer effects.

Overall, all information ATSDR reviewed to date suggests three key findings for cadmium: 1) the TSCA Incinerator has relatively minor air quality impacts; 2) the inhalation exposures that residents might experience are not unusually high when compared with those observed in other parts of the country; and 3) the actual exposure levels are not expected to cause adverse cancer or non-cancer health effects. Section IV.D discusses future actions that are warranted to ensure that cadmium exposures remain at safe levels in the future.

IV.C. Chromium

Evaluating ambient air contamination of chromium often presents challenges: chromium exists in multiple forms, each having a significantly different toxicity. The most common forms found in ambient air are trivalent chromium and hexavalent chromium. Trivalent chromium is relatively benign and is actually an essential nutrient for humans. Hexavalent chromium is considerably more toxic, both for cancer and non-cancer outcomes. Complicating matters is the fact that most commonly used environmental sampling and analytical methods measure ambient

air concentrations of total chromium, without specifying the relative amounts of the hexavalent and trivalent forms.

When conducting the screening analysis (see Section III), ATSDR initially assumed that all chromium is present in the more toxic hexavalent form. Under this assumption, both modeled and measured levels of total chromium exceeded the health-based comparison values for hexavalent chromium — this comparison does not mean that the measured chromium levels are necessarily harmful or are even caused largely by the incinerator's emissions. Rather, the initial comparison simply means that further evaluation is needed to assess the public health implications of exposure to chromium. The following paragraphs present ATSDR's more detailed evaluations of exposures to chromium, which consider the reality that total chromium includes both trivalent and hexavalent forms:

- **Consistency with modeling results.** The highest annual average concentration of total chromium reported for DOE's monitoring network is <0.0064 μg/m^3, at a monitoring station on the perimeter of ETTP.4 For comparison, the dispersion modeling analysis conducted by the Governor of Tennessee's independent panel estimated that the highest annual average air concentration of total chromium attributed to the TSCA Incinerator's emissions was only 0.000153 μg/m^3, which is more than 40 times lower than the detection limit for annual average concentrations in DOE's network. The considerably higher measured levels of total chromium probably reflect the influence of air emissions sources other than the TSCA Incinerator.

- **Comparison with typical airborne chromium levels.** Two ambient air monitoring stations at ETTP measured ambient air concentrations of total chromium for almost the entire history of the TSCA Incinerator's operations. Over nearly 10 years of monitoring at stations K2 and K6 (see Figure C-3 for their locations), the long-term average ambient air concentrations of total chromium were 0.0006 μg/m^3 and 0.0005 μg/m^3, respectively.

  The total chromium concentrations measured around ETTP clearly fall within the range of concentrations reported for similar settings. For instance, ATSDR reports that average airborne concentrations of total chromium in rural settings are generally lower than 0.010 μg/m^3 (ATSDR 2000b). Similarly, ambient air monitoring that EPA recently conducted at a remote location near Louisville, Kentucky, found an annual average concentration of total chromium of 0.0027 μg/m^3 (EPA 2002). Moreover, ongoing ambient air monitoring in Nashville for an EPA nationwide monitoring network has shown that average concentrations of total chromium are approximately 0.004 μg/m^3 (ERG 2004). In short, extensive ambient air monitoring data collected elsewhere in the country suggest that the annual average concentrations of total chromium measured near ETTP are not unusually elevated.

- **Toxicological evaluation.** ATSDR's toxicological evaluation focuses on hexavalent chromium, which is the most toxic form of chromium likely to be encountered in the environment.

4 The annual average concentration was calculated from a data set in which chromium was not detected in several samples. When calculating annual average concentrations, DOE apparently replaced non-detect observations with the detection limit to generate an upper-bound estimate of actual chromium levels. This is why a "less than" symbol appears before the annual average concentration.

Non-cancer evaluation. To assess potential non-cancer outcomes, ATSDR considered EPA's reference concentration (RfC) for hexavalent chromium particulates, which is 0.1 $\mu g/m^3$. By definition, an EPA RfC represents an exposure concentration that is likely to be without harmful health effects throughout a lifetime of continuous inhalation exposure. Because the highest long-term average measured concentration of total chromium (0.0006 $\mu g/m^3$) is more than 150 times lower than the RfC, ATSDR concludes that residents' exposures to chromium near the TSCA Incinerator are not expected to cause non-cancer health effects, even if one assumes that all of the airborne chromium is in the more toxic hexavalent form.

Cancer evaluation. According to NTP, hexavalent chromium is a "known human carcinogen." Consensus agencies have not classified the carcinogenicity of trivalent chromium, but ATSDR has noted that epidemiological studies in industries where workers are exposed to trivalent chromium have been consistently negative (ATSDR 2000b). Therefore, the evaluation of potential cancer outcomes in this PHA focuses primarily on hexavalent chromium exposures. ATSDR would prefer to base this evaluation on measured ambient air concentrations of hexavalent chromium, rather than on measures of total chromium. As is typical, however, at many sites that ATSDR evaluates, no data are available on the relative amounts of hexavalent and trivalent chromium in the air near the TSCA Incinerator.

Nonetheless, ATSDR believes the available data provide ample insights on the potential for cancer outcomes resulting from inhaling hexavalent chromium, even without the chemical speciation data. Specifically, ATSDR's Toxicological Profile for Chromium presents 11 different cancer effect levels: 10 for studies of human exposures (mostly occupational) and one for an animal study (ATSDR 2000b). The lowest cancer effect level reported is 40 $\mu g/m^3$ for an occupational cohort that was exposed to a mixture of trivalent and hexavalent chromium. In contrast, the highest long-term average exposure concentration near the TSCA Incinerator is more than 66,000 times below the lowest cancer effect level. Such a large margin of safety provides assurance that the exposures that community members near ETTP experience do not reach levels known to be associated with cancer outcomes.

An important consideration in this evaluation is the chemical form of chromium found in the air near the TSCA Incinerator, given that hexavalent chromium appears to be a much more potent carcinogen. While the chemical speciation issue cannot be resolved from the available measurements, ATSDR notes that a growing body of evidence from EPA monitoring networks is showing that hexavalent chromium typically accounts for less than 10% of total chromium in ambient air (e.g., Swift et al. 2003). Moreover, studies have suggested that hexavalent chromium typically accounts for less than 1% of air emissions of total chromium from municipal waste incinerators (ATSDR 2000b). The qualitative insights on chemical speciation combined with the large margin between exposure levels and cancer effect levels strongly suggest that the TSCA Incinerator does not emit chromium in amounts believed to be associated with cancer outcomes.

The previous evaluation shows that air emissions of chromium from the TSCA Incinerator appear to contribute only slightly to ambient air concentrations of chromium near ETTP. Further, the measured ambient air concentrations of total chromium fall within the range of concentrations expected for a rural location. While the relative amounts of trivalent chromium

and hexavalent chromium in ambient air near ETTP are not known, ATSDR's evaluation strongly suggests that realistic estimates of inhalation exposures are below levels of health concern, both for cancer and non-cancer outcomes.

IV.D. Summary

The foregoing is ATSDR's evaluation of public health implications of exposure to arsenic, cadmium, and chromium in ambient air near the TSCA Incinerator. For all three metals, the available sampling and modeling data suggest that emissions from multiple local sources, and not just the TSCA Incinerator, contribute to the measured airborne concentrations. Regardless of the predominant source of the metals, the airborne concentrations measured near ETTP are reasonably consistent with those measured in rural and suburban areas across the country. Further, and more importantly, inhalation exposures to the measured concentrations are at levels well below those observed to be associated with adverse health effects, both in animals and in humans.

The conclusions in this section rest heavily on trends among nearly 10 years of ambient air monitoring data that DOE has collected in the vicinity of the TSCA Incinerator, including at a location believed to be near where the incinerator's emissions have their greatest air quality impacts. While the data generated by DOE appear to be of a known and high quality and provide a sound basis for this PHA's conclusions, an excellent opportunity exists to provide independent verification of DOE's air quality measurements for arsenic, cadmium, and chromium. Specifically, TDEC is currently measuring ambient air concentrations of metals at one of the locations where DOE also measures ambient air concentrations of metals. To provide insights into measurement accuracy, ATSDR recommends TDEC quantify differences between metals monitoring data gathered by DOE and those gathered by TDEC at all stations with co-located samplers. Although the TSCA Incinerator does not appear to be the primary source of arsenic, cadmium, and chromium in the ambient air, ATSDR recommends that DOE and TDEC continue routine ambient air monitoring as long as the TSCA Incinerator processes waste. This will provide assurance that incinerator emissions, in combination with emissions from other sources, do not result in unacceptable exposures. Section IX of this PHA presents these and other recommendations that ATSDR has made for this site.

V. Community Health Concerns

One objective of this PHA is to respond to specific community concerns about the TSCA Incinerator. This section presents responses to all such concerns that residents have expressed to ATSDR to date. Throughout the health assessment process, ATSDR has compiled a list of community concerns by drawing from ATSDR's database of concerns for the ORR facilities[5], TDEC's report addressing community concerns (TDEC 1997), and the summary report issued by a group of independent experts chartered by the Governor of Tennessee (Iglar et al. 1998). ATSDR also identified community concerns by talking to local residents, whether at public meetings or through individual communications. The remainder of this section uses a question and answer format to address specific community concerns, which are organized into four topics.

V.A. Community Concerns Regarding Health

Sections III and IV of this PHA present ATSDR's findings regarding the public health implications of exposure to air contaminants released by the TSCA Incinerator. The following questions and answers elaborate on specific health issues of concern to some community members.

Question A-1:

Under certain meteorological conditions, air emissions from the TSCA Incinerator appear to blow directly to ground level at on-site locations. Does this situation present a health hazard to visitors to the property, particularly for exposures to mercury?

Answer A-1:

Many factors determine how contaminants disperse from a stack into the atmosphere. These factors include the stack gas temperature and exit velocity, the stack's dimensions, the stack's proximity to nearby buildings, and local meteorological conditions. Under certain circumstances, stack gas emissions have been observed to blow rapidly to the ground — a phenomenon known as "downwash."

The conditions that cause severe downwash at the TSCA Incinerator typically are short-lived; that is, they likely do not persist for hours on end. ATSDR has received no reports that during downwash conditions, site visitors were ever directly exposed to stack emissions. Further, ATSDR expects that should downwash conditions be observed while visitors are touring the facility, escorts would guide any visitors away from these emissions. Accordingly, ATSDR suspects that visitors' exposures to air emissions during downwash conditions are extremely limited, if they occur at all.

[5] From 2001 to 2003, ATSDR compiled more than 3,000 community health concerns obtained from the ATSDR/ORRHES community health concerns comment sheets, written correspondence, phone calls, newspapers, comments made at public meetings (ORRHES and work group meetings), and surveys conducted by other agencies and organizations. These concerns were organized in a consistent and uniform format and imported into the database. This section includes those concerns that (1) were specific to the TSCA Incinerator and (2) were not already addressed in other parts of this document.

A community member asked ATSDR specifically about whether this scenario could lead to mercury exposures that would cause visitors to get sick. Such an outcome is unlikely for two reasons. First, the TSCA Incinerator has extremely strict Waste Acceptance Criteria for materials that contain mercury to ensure that emissions are safely below levels that would lead to unacceptable air quality impacts. Second, according to ATSDR's Toxicological Profile for Mercury (ATSDR 1999b), the lowest air concentrations of mercury that have been shown to cause adverse health effects following exposures over short time frames (e.g., hours) are more than 20,000 $\mu g/m^3$. Considering that none of the metals reached concentrations of even 1 $\mu g/m^3$ at off-site locations, it is highly unlikely that mercury concentrations could reach harmful levels for acute exposures, even when considering direct downwash of the plume.

Question A-2:

Are workers at the TSCA Incinerator at risk for developing adverse health effects, due to their occupational exposures?

Answer A-2:

As noted earlier in this PHA, ATSDR's role at the ORR facilities is to evaluate environmental health issues, not occupational health issues. Nonetheless, ATSDR recognizes that many residents have health concerns specific to occupational exposures.

There are several resources that residents can consult for more information on occupational health issues. Web sites maintained by DOE (http://cedr.lbl.gov) and NIOSH (http://www.cdc.gov/niosh/2001-133.html), for example, describe ongoing worker health studies at several existing and former DOE facilities. One reference available is a NIOSH study that found no evidence of significant occupational exposures to hydrogen cyanide and related compounds at the TSCA Incinerator (Blade and Worthington 1996). Further, the independent panel's summary report (Iglar et al. 1998) and ATSDR's review of thermal treatment technologies (ATSDR 2002) comment on more general occupational health issues observed at incineration facilities.

Question A-3:

Will ATSDR establish a health clinic for residents who live near the TSCA Incinerator?

Answer A-3:

ATSDR does not establish site-specific health clinics. In a February 22, 1999, letter from Donna E. Shalala, Secretary of Health and Human Services, to The Honorable William H. Frist, M.D., United States Senate, Secretary Shalala stated that ATSDR and CDC cannot provide direct primary medical services to communities. ATSDR and CDC can, however, support the existing medical care systems to address public health concerns of communities that are near nuclear plants. ATSDR is working with ORRHES, EPA, TDEC, the Tennessee Department of Health, and DOE to plan appropriate public health follow-up activities to address the concerns of communities regarding the nuclear weapons complexes. In August 2002, the ORRHES recommended that formal consideration of establishment of a clinic,

clinical evaluations, medical monitoring, health surveillance, health studies, or biological monitoring be postponed until the ATSDR public health assessment process identified and characterizes an exposure of an off-site population at levels of health concern. As Sections III and IV of this PHA explain, ATSDR found no evidence of local residents being exposed to unhealthful levels of air pollution in the vicinity of the TSCA Incinerator. Accordingly, ATSDR does not believe follow-up public health activities are necessary to address the releases from the TSCA Incinerator.

Question A-4:

Does ATSDR's evaluation consider peak emission rates expected to occur from the TSCA Incinerator, such as those during TRV events?

Answer A-4:

Yes. This PHA examines both routine and peak exposures as characterized by average and maximum concentrations among ambient air monitoring data. It also presents detailed evaluations of TRV events, which are assumed to lead to the highest short-term exposures, given that incinerator gases are released without first passing through air pollution controls. ATSDR's evaluation found that both short-term and long-term exposures did not reach levels expected to cause adverse health effects.

Question A-5:

Does the TSCA Incinerator release beryllium at levels of health concern?

Answer A-5:

No. Ambient air monitoring for beryllium has occurred over nearly the entire history of the TSCA Incinerator's operations at the location predicted to have the greatest air quality impacts. As Table C-3 shows, even the highest concentration of beryllium measured to date did not exceed protective health-based comparison values. Therefore, ATSDR concludes that the air emissions of beryllium from the TSCA Incinerator are not at levels of health concern.

Question A-6:

Several community members expressed concern about the possibility of adverse health effects occurring as a result of exposure to air emissions from the TSCA Incinerator. In one case, for instance, a community member noted that the onset of adverse health effects corresponded with the time the TSCA Incinerator began routine operations. In another case, a community member noted that onset of adverse health effects occurred shortly after a perceived exposure to emissions from the source.

Answer A-6:

ATSDR considered the various community health concerns when preparing this PHA. The analyses in this PHA document the multiple lines of evidence ATSDR evaluated to assess the possibility of air emissions from the TSCA Incinerator causing adverse health effects among nearby community members. Specifically, ATSDR critically reviewed the design and operation of the incinerator, amount and composition of waste treated, emissions data, fate and transport modeling studies, and ambient air sampling and monitoring studies. Every line of evidence considered showed that the TSCA Incinerator's emissions do not lead to

exposure levels associated with adverse health effects. Further, continued operation of the TSCA Incinerator is not expected to cause harmful exposures in the future because numerous safeguards, pollution controls, and strict permitting requirements are in place to prevent unsafe operating conditions from occurring.

V.B. Community Concerns Regarding Environmental Contamination

Section III and Appendixes A through C of this PHA present ATSDR's evaluation of the air exposure pathway for the TSCA Incinerator. The following discussion addresses concerns that community members have previously expressed to ATSDR about local air emissions sources, measured environmental contamination levels, and potential ecological effects from the incinerator's emissions.

Question B-1:

Do available monitoring data form a sufficient basis for conclusions on this site?

Answer B-1:

As Appendixes A and C show, multiple parties have conducted numerous sampling and monitoring studies to characterize the TSCA Incinerator's emissions and air quality impacts. These studies considered the contaminants of greatest concern for incineration facilities, focused on locations where air quality impacts are expected to be greatest, and were conducted over almost the entire history of the incinerator's operations. ATSDR believes that the available emissions monitoring data and ambient air monitoring data are generally consistent and provide an adequate basis for scientifically defensible public health conclusions regarding the TSCA Incinerator.

Question B-2:

To what extent do air emissions from sources other than the TSCA Incinerator, particularly the nearby power plants, contribute to local air pollution?

Answer B-2:

The air that local residents breathe contains trace contamination that originates from many different sources, including industrial sources, mobile sources, and natural sources. Section II.E.1 of this PHA identifies several local air emissions sources and describes, in general terms, how they affect local air quality. For additional perspective on power plants, ATSDR examined the most recent TRI data for all electricity-generating facilities within 25 miles of ETTP and found the following:

Facility Name (as listed in TRI)	*Total Air Emissions of Toxic Chemicals in 2001 (Pounds)*
U.S. DOE East Tennessee Technology Park	83
U.S. TVA Kingston Fossil Plant	5,926,225
U.S. TVA Bull Run Fossil Plant	4,305,815

This previous data compilation shows that the local power plants emit far greater quantities of toxic chemicals into the air than does the TSCA Incinerator. ATSDR strongly cautions about what readers should infer from the data shown above, because comparisons of total TRI emissions does not consider a) releases of all contaminants, b) the toxicity of the individual chemicals emitted, and c) important air dispersion behavior. For instance, because the power plants have such tall stacks, the plants' emissions can travel long distances (and become increasingly less concentrated) before they ever reach ground level. In summary, ATSDR presented the TRI emissions data above to respond to a very specific community concern; however, it is critically important that these data be considered in proper context.

While this PHA does not focus on environmental health issues specific to the local power plants, ATSDR notes that the ambient air monitoring data collected in the vicinity of the TSCA Incinerator reflect potential air quality impacts from the local power plants, the TSCA Incinerator, and other air emissions sources. Therefore, this PHA implicitly considers how air emissions from nearby TVA facilities affect air quality near the TSCA Incinerator.

Question B-3:

Does the TSCA Incinerator contaminate environmental media other than air, whether through direct discharges (e.g., wastewater) or through indirect pathways (e.g., air contaminants depositing onto soils and being taken into the food chain)? If so, does this contamination present a health hazard?

Answer B-3:

The analyses in this PHA focus almost entirely on direct inhalation exposures to airborne contaminants near the TSCA Incinerator, which presents the most likely pathway by which residents might come into contact with site-related contaminants. ATSDR also considered the specific issues raised in the comment, regarding potential contamination of other environmental media:

- **Direct discharges.** Residuals from the TSCA Incinerator are managed according to applicable permits and waste management regulations; no residuals are released directly into the environment.

  The incinerator's liquid residuals, for instance, are pumped to ETTP's wastewater treatment plant, known as the Central Neutralization Facility. The treated water eventually flows into the Clinch River. To fulfill permit requirements, DOE regularly tests the treated water in outfalls to the Clinch River. The testing must measure concentrations of numerous contaminants, including metals, radionuclides, and selected

organic compounds. ATSDR reviewed data summaries for these sampling efforts, which show that contaminant levels in the water discharged from ETTP to the Clinch River have been consistently below maximum limits established in the environmental permits (DOE 1991–2002).

ATSDR also considered the fate of the ash and sludge residuals that the TSCA Incinerator generates. Since 1991, DOE has handled these wastes according to EPA's waste management regulations. These regulations require DOE to test the ash and sludge for chemical contamination, and then to handle the materials accordingly. Depending on the testing results, the ash and sludge are either treated further or sent off site (typically to landfills) for waste management. Thus, solid residuals also are not released directly into the environment.

- **Indirect contamination pathways.** Residents have asked that ATSDR consider the possibility that pollutants released by the TSCA Incinerator might eventually contaminate other media. For example, contaminants in air emissions might deposit on soils or surface waters, and then become available for accumulation into biota. ATSDR is currently preparing a separate PHA on the extent of environmental contamination that has recently been measured in soils, surface water, and biota at locations outside the ORR property line. That "chemical screening" PHA will consider the possibility of indirect contamination caused by the TSCA Incinerator's air emissions. ATSDR expects that the chemical screening PHA will be completed early in 2005.

Question B-4:

Have emissions from the TSCA Incinerator killed pine trees in downwind locations?

Answer B-4:

In the mid-1990s, residents expressed concern that air emissions from the TSCA Incinerator might have killed a group of pine trees located immediately downwind from the facility. The independent panel chartered by the Governor of Tennessee evaluated this issue and concluded that the pine trees were killed primarily by southern pine beetle infestations. These beetle infestations reportedly have caused extensive damage to local trees throughout and beyond ORR (Iglar et al. 1998).

Question B-5:

Has ATSDR considered ambient air monitoring data collected by TVA?

Answer B-5:

During the March 2004 PHAWG meeting when ATSDR presented its preliminary evaluation for the TSCA Incinerator, a community member recommended that ATSDR contact TVA to determine if that agency has collected ambient air monitoring data relevant to this PHA. ATSDR has since obtained data from TVA, which are summarized in Appendix C of this PHA.

Question B-6:

Are the locations chosen for ambient air monitoring and ambient air sampling adequate?

Answer B-6:

Yes. Parties who conduct ambient air monitoring and ambient air sampling studies face difficult decisions when deciding where to place their equipment. On the one hand, there is often a desire to know ambient air concentrations of contaminants at as many places as possible; on the other hand, operating numerous monitoring stations can be prohibitively expensive. To achieve an appropriate balance, scientists typically conduct and carefully review air dispersion modeling studies before deciding where to place monitoring stations. This was done for the TSCA Incinerator, and ambient air concentrations have been measured at locations (both upwind and downwind) believed to have the greatest air quality impacts. Additionally, ambient air monitoring and ambient air sampling takes places at locations between the incinerator and the nearest residential receptors. As a result, it is extremely unlikely that the current monitoring network is grossly underestimating site-related exposures. Consequently, ATSDR believes the monitoring and sampling data are a sufficient basis for reaching public health conclusions, especially when one considers the consistent insights offered by a review of information on emissions and fate and transport.

Question B-7:

Has DOE measured fugitive emissions from the TSCA Incinerator? If fugitive emissions have not been measured, how can ATSDR reach a definitive conclusion on this site, and should DOE be required to measure these emissions?

Answer B-7:

By their very nature, fugitive emissions are extremely difficult, if not impossible, to measure directly. Consequently, DOE has never measured, nor been required to measure, fugitive emissions from the TSCA Incinerator. ATSDR does not view the lack of fugitive emission measurements as a significant data gap for this PHA for two reasons. First, several design and operational features clearly minimize potential fugitive emissions from this source (see Section III.B.3). Second, the ambient air monitoring data that ATSDR reviewed reflects air quality impacts from all local emissions sources, including the fugitive emissions from the TSCA Incinerator. Consequently, ATSDR's evaluation implicitly considered the incinerator's fugitive emissions, even though they have never been directly measured.

Question B-8:

At what location do air emissions from the TSCA Incinerator have their greatest air quality impacts?

Answer B-8:

Local meteorological conditions determine how emissions move from the incinerator stack to off-site locations. As the wind speed and direction change, so does the location with the highest ground-level concentration. As Appendix B describes, the existing dispersion modeling studies have estimated where the incinerator's emissions are expected to have their

greatest air quality impacts over the long term. All the studies ATSDR reviewed place the point of maximum impact within ½-mile of the stack base, in areas where no residents live or frequent. It should be noted, however, that ambient air monitoring stations have been placed at the estimated locations of maximum impact.

Question B-9:

Did ATSDR consider air emissions from local medical waste incinerators and municipal solid waste incinerators?

Answer B-9:

To identify nearby medical waste incinerators and municipal waste incinerators, ATSDR consulted with EPA personnel responsible for tracking the permit status of selected facilities in the United States. Through this consultation, ATSDR learned that there currently are no medical waste incinerators or municipal waste incinerators in the Knoxville metropolitan area that process enough material to fall under EPA's most recent regulations on incineration. Thus, if any medical waste incinerators or municipal solid waste incinerators are located in the Knoxville area, they must process very small quantities of waste. Moreover, air quality impacts from such facilities, if they exist, would presumably be captured in the ambient air monitoring data that ATSDR reviewed for this site.

V.C. Community Concerns Regarding Incinerator Operations

ATSDR identified several community concerns regarding the operation of the TSCA Incinerator, with most expressed during the March 2004 PHAWG meeting. ATSDR's responses to these concerns follow. Recognizing that residents have lingering questions about the incinerator's operations and the extent of regulatory oversight, ATSDR has recommended that TDEC issue annual fact sheets to inform the public of the TSCA Incinerator's ongoing operational status (see Section IX for further information on this and other recommendations).

Question C-1:

Why has DOE not implemented continuous emissions monitoring systems for a wider set of pollutants?

Answer C-1:

As Appendix C indicates, DOE currently conducts continuous emissions monitoring for carbon dioxide, carbon monoxide, and oxygen. Additionally, DOE continuously samples stack gases to measure emission rates of metals and radionuclides. Taken together, these continuous emissions monitoring and continuous emissions sampling efforts meet all applicable regulatory requirements for emissions measurements.

While ATSDR can appreciate the desire to have real-time emissions measurements for a broader range of contaminants, reliable continuous measurement devices simply are not available for every contaminant released by incinerators. ATSDR does not view the lack of additional continuous monitoring data as a critical information gap for this site for two reasons. First, ATSDR emphasizes that continuous emissions sampling already occurs for metals and radionuclides — two groups of contaminants that incinerators do not destroy.

Second, safeguards are in place to ensure that air emissions of other contaminants do not exceed levels of health concern. For instance, maintaining operating parameters within limits established during the trial burns should ensure that organic compounds and PCBs in wastes are thoroughly destroyed. Therefore, ATSDR believes that DOE's current emissions monitoring and emissions sampling strategies are appropriate.

Question C-2:

If continuous emissions monitoring for PCBs does not occur, how does DOE know that the DRE for PCBs is consistently greater than 99.9999%?

Answer C-2:

No continuous emissions monitoring systems are currently available for PCBs in incinerator exhaust. However, EPA's permitting process for incinerators includes several measures that help ensure that facilities consistently meet required DREs. For instance, through the trial burn process, EPA requires facility operators to demonstrate that their incinerators can adequately destroy wastes, even under unfavorable operating conditions. Further, environmental permits are prepared that establish strict waste acceptance criteria and specify limits on several critical operating parameters in the interest of ensuring that adequate waste destruction occurs. Finally, continuous emissions monitoring is required for carbon dioxide, carbon monoxide, and oxygen; results from this monitoring can characterize incineration efficiency. Thus, even though continuous monitoring of DREs for PCBs is currently not feasible, multiple safeguards are in place to help ensure (though not necessarily prove) that the required DREs are met.

Question C-3:

How can stack tests conducted every 5 years characterize how air emission rates at the TSCA Incinerator vary from day to day?

Answer C-3:

This question addresses a key issue often debated in connection to regulatory strategies for air emissions sources. Given the costs of conducting stack tests, environmental regulators have long recognized that frequent stack testing can be prohibitively expensive for incinerator operators. Regulators have instead focused on an alternate approach to ensuring safe operation of incineration facilities: carefully establishing waste acceptance criteria and limits on critical operating parameters to ensure (with an adequate margin of safety) that incinerator emissions are not harmful. Periodic stack tests are then used to confirm that the permit conditions are indeed appropriate. ATSDR believes that this is a sensible approach and avoids placing an undue financial burden on incinerator operators to demonstrate regulatory compliance.

Question C-4:

Is all waste material being characterized before being treated at the TSCA Incinerator?

Answer C-4:

Wastes must be thoroughly characterized, whether through testing or demonstrated process knowledge, before they can be treated at the TSCA Incinerator. DOE must retain records of waste characterization efforts, and TDEC periodically reviews records to verify compliance with permit conditions. Failure to perform waste characterization carries serious consequences. For instance, the DOE contractors who operate the incinerator can be subject to expensive fines (and, in extreme cases, criminal investigation) if waste characterization is not adequately performed. Overall, ATSDR has no reason to believe that DOE is treating improperly characterized wastes at the TSCA Incinerator.

Question C-5:

Given that incinerators do not destroy metals or radionuclides, why is incineration used to treat wastes containing these contaminants?

Answer C-5:

It is ATSDR's understanding that DOE is not using incineration to treat wastes heavily contaminated with radionuclides. Rather, the wastes of concern predominately contain toxic organic constituents (like PCBs) that need to be destroyed. Incineration has been shown to safely destroy these toxic constituents without generating and emitting harmful levels of by-products.

The toxic organic wastes that DOE treats at the TSCA Incinerator also happen to contain small amounts of metals or radionuclides. Recognizing this, DOE designed the incinerator with extensive air pollution controls to remove metals, radionuclides, and other inorganic materials that are not destroyed in the process. Stack testing has shown that the air pollution control devices at the TSCA Incinerator efficiently remove metals or radionuclides from gases leaving the afterburner. Some estimates place these removal efficiencies well over 90%, depending on the metal or radionuclide of concern. Regardless of the actual removal efficiencies, trace amounts of metals and radionuclides undoubtedly pass through the incinerator untreated. However, an extremely large volume of ambient air monitoring data show that these emissions have only marginal impacts on local air contamination levels and the measured air concentrations of metals and radionuclides are below levels of health concern.

Question C-6:

Does DOE operate the TSCA Incinerator outside of the bounds established in the environmental permits?

Answer C-6:

The incinerator automatically shut downs whenever one of several critical operating parameters (see Table 3) falls outside acceptable ranges specified in the environmental permits. These critical operating parameters are continuously measured using automated

sensors. Therefore, ATSDR has no reason to believe that DOE or its contractors can or would intentionally operate the incinerator beyond its permitted bounds.

Question C-7:

Given that the TRV remains open when the TSCA Incinerator is not operating, do emissions routinely occur through the TRV during typical process startups and shutdowns?

Answer C-7:

The question correctly notes that the TRV at the TSCA Incinerator is in the open position when the incinerator is not operating. During startup, a process interlock prevents the incinerator from operating until the TRV is in the closed position. Therefore, all combustion gases generated after process startup cannot pass through the TRV. Similarly, during process shutdown, the TRV remains in the closed position until after all combustion gases have passed through the air pollution controls. Therefore, whether during startup conditions, routine operations, or shutdown conditions, incineration gases pass through the air pollution controls and are not vented through the TRV. Only during the 18 events listed in Table 2 were untreated gases released through the TRV.

V.D. Other Community Concerns

The following paragraphs present ATSDR's responses to general community concerns that do not fall under the categories listed above.

Question D-1:

Does trucking hazardous wastes to the TSCA Incinerator present a hazard?

Answer D-1:

As noted previously, the TSCA Incinerator treats wastes generated by multiple DOE facilities, not just the ORR facilities. Selected wastes from other DOE facilities are shipped to the TSCA Incinerator by truck. ATSDR acknowledges that untreated hazardous wastes might be released if any trucks were involved in serious accidents. However, the U.S. Department of Transportation has developed many regulations to prevent such releases or minimize their consequences. For instance, drivers who haul hazardous waste must have special licenses, waste materials must be packaged in containers designed to withstand traumas anticipated in certain accidents, and wastes must be labeled and tracked. ATSDR believes these and other safeguards help minimize any hazards associated with transporting hazardous wastes to the TSCA Incinerator. While none of these regulations can guarantee that no accidents involving waste shipments will ever occur, it is worth noting that the TSCA Incinerator has now operated for 14 years without any accidents involving hazardous waste shipments.

Question D-2:

Has ATSDR evaluated the quality of the monitoring data reported by DOE?

Answer D-2:

ATSDR carefully scrutinized the quality of all sampling results relevant to the TSCA Incinerator, regardless of which party had collected the data. For reasons stated in Appendix C, ATSDR believes the monitoring data provided by DOE are generally of a known and high quality. Moreover, ATSDR sought additional data sources to provide independent verification for the quality of DOE's data. For instance, the consistency between EPA's and DOE's environmental radiation measurements near ETTP provide assurance that the underlying measurements are accurate. Similarly, ATSDR recommends that TDEC conduct similar data comparisons between its metals monitoring data and DOE's or provide some other form of independent verification of DOE's metals data (see Section IX).

Question D-3:

Did ATSDR consider findings from researchers at the University of California at Los Angeles (UCLA) suggesting that metals should not be incinerated?

Answer D-3:

During the PHAWG meeting when ATSDR presented its preliminary evaluation of the TSCA Incinerator, a community member noted that researchers at UCLA published a paper suggesting that metals should never be incinerated. After the meeting, ATSDR asked the individual who made these comments to provide a copy of the publication cited. The information provided was not a peer-reviewed publication, but rather a printed copy of UCLA's Center for Clean Technology Web site. Thus, ATSDR has no knowledge of UCLA researchers making the statements attributed to them. More generally, however, ATSDR has already stated its position on the utility of incineration as a waste management alternative: "Thermal treatment technologies [including incineration] are inherently neither safe nor unsafe; whether they are safe depends on how they are designed and operated" (ATSDR 2002).

Question D-4:

Did ATSDR consider findings from DOE's Lawrence Livermore National Laboratory (LLNL) suggesting that radioactive materials should never be incinerated?

Answer D-4:

During the same PHAWG meeting in March 2004, a community member noted that DOE had previously reported that radioactive materials should never be incinerated. ATSDR obtained a copy of the report that appeared to form the basis for this comment (DOE 1990). The report evaluated whether DOE should install and operate an incinerator at LLNL to treat mixed LLW. After considering many factors, the authors of the report did in fact conclude that a new incinerator should not be constructed. It is important to note that the authors did not conclude that mixed LLW should never be incinerated; rather, the conclusion was that this incineration did not need to take place at LLNL, in part because these wastes could be shipped to other DOE installations that already have permitted incinerators.

Overall, the report that ATSDR obtained suggests that whether incineration is an appropriate waste treatment technology ultimately needs to be decided on a case-by-case basis. As stated earlier, the purpose of this PHA is not to enter into the debate on the utility of incineration, but rather to assess the public health implications of environmental releases specifically from the TSCA Incinerator.

Question D-5:

Is the white smoke in the incineration emissions harmful?

Answer D-5:

A major by-product of incineration processes is water. Because the stack gases at the TSCA Incinerator are typically at least 170 degrees Fahrenheit, some of the water in the air emissions exists as vapor. Once these gases come into contact with cooler ambient air, some water vapor condenses and becomes steam, which is visible. Of course, the incinerator emissions include trace amounts of other contaminants, as Section III of this PHA describes. Still, a large volume of measured and modeled data indicate that residents are not exposed to these chemicals at levels expected to cause adverse health effects.

Question D-6:

If most TRV events are caused by power outages, how does DOE collect air samples during these events?

Answer D-6:

The TSCA Incinerator and the off-site ambient air monitoring networks draw from different power sources. As evidence of this, valid air samples have been collected at the off-site monitoring network during several of the TRV events that were caused by power outages.

VI. Health Outcome Data

Health outcome data, or measures of disease occurrence in a population, can provide information on the general health status of a community. ATSDR scientists evaluate health outcome data in PHAs typically for one of two reasons: 1) to evaluate the possible health effects in a population that is known to have been exposed to enough environmental contamination to experience health effects or 2) to help address community concerns about a particular illness in a community. As the previous sections of this PHA have explained, ATSDR has found no evidence of residents being exposed to the TSCA Incinerator's emissions at levels of health concern. ATSDR found, however, ample evidence of general community health concerns regarding the TSCA Incinerator.

Over the past few decades, government agencies, academic researchers, and other parties have completed several epidemiological studies to evaluate incineration facilities. While none of the studies focused specifically on the TSCA Incinerator, the studies do provide useful perspective on environmental health issues at incineration facilities. The following paragraphs summarize two extensive literature reviews of selected, peer-reviewed environmental health studies on incinerators and related facilities. Occupational health studies are not considered below, but Section V provides some information on occupational health concerns associated with incineration facilities.

Epidemiological studies show that well-designed and properly operated incinerators generally can destroy wastes without presenting a substantial health risk to nearby residential populations.

- **ATSDR's review of health outcome data.** Since its inception, ATSDR has conducted or funded six health studies that focused on environmental health concerns associated with incineration facilities in the United States. In 2002, ATSDR reviewed the findings of these studies (ATSDR 2002). With one exception, the studies found no association between residents' proximity to incinerators and any biomarkers of exposure or adverse health effects. The exception was a study that found residents near a former incineration facility had a higher prevalence of self-reported respiratory symptoms (though not a higher prevalence of physician-diagnosed respiratory disease) than did residents in the study's control population. ATSDR concluded that this incinerator, because it operated without any air pollution controls and had a record of extremely poor waste handling practices, was "…not representative of hazardous waste combustion facilities operating today" (ATSDR 2002). From all studies combined, ATSDR concluded that hazardous waste incineration could be done in a safe manner, depending largely on the incinerator design and operational details.

- **NRC's review of selected epidemiological studies.** In 2000, NRC published a review of selected epidemiological studies conducted around incineration facilities in the United States, the United Kingdom, France, Taiwan, and Australia (NRC 2000). NRC concluded that the epidemiological studies provide no evidence of an association between exposure to incinerator emissions and acute or chronic respiratory symptoms among exposed residential populations. NRC acknowledges, however, that the failure to detect effects might reflect methodological limitations of epidemiological studies, such as evaluating small study populations and not fully considering impacts from confounding factors. In its review of epidemiological studies and other issues pertaining to incineration facilities, NRC ultimately

concluded that "…a well-designed and properly operated incineration facility emits relatively small amounts of [air] pollutants, contributes little to ambient concentrations, and so is not expected to pose a substantial health risk" (NRC 2000).

In summary, no researchers have conducted epidemiological studies of residents who live in the vicinity of the TSCA Incinerator. However, ATSDR's environmental health evaluations presented earlier in this PHA strongly suggest that such a study is not warranted, given that residents are not exposed to site-related contaminants at levels of health concern. Further supporting this conclusion are health outcome data suggesting that well-designed and properly operated incinerators — such as the TSCA Incinerator — can destroy wastes in a safe manner without compromising the health of local residents.

VII. Children's Health Considerations

Because children often are at greater risk than adults of being exposed to toxic chemicals, and because 8% of the residential population within 3 miles of the TSCA Incinerator are children (age 6 year and under), ATSDR specifically considered children's health issues when preparing this PHA. Children are more likely than adults to suffer from adverse health effects due to environmental exposures for several reasons, such as:

- Children's developing bodies can be particularly sensitive to environmental exposures during certain critical growth stages, especially when children are exposed to contaminants known to cause developmental effects.
- Children weigh less than adults. Thus, when children and adults ingest or inhale the same amount of chemicals, children receive a greater dose than adults, on a pound of contaminant per pound of body weight basis.
- Because children often spend more time outdoors than do adults, children can be more likely to come into contact with contaminated soils and to inhale greater amounts of outdoor air pollution.

Throughout the PHA process, ATSDR considered these and other children's health issues. For instance, when selecting health-based comparison values for the exposure evaluation, ATSDR identified, when available, comparison values protective of children's exposure and of health conditions more common in children, like asthma. As one example, ATSDR used EPA's air quality standards to screen air contamination levels for lead, ozone, and particulate matter. EPA developed these standards to protect the health of sensitive populations, including children.

ATSDR identified one environmental health issue of particular concern to children for this site: elevated airborne levels of ozone and fine particulates. Many children who live near the TSCA Incinerator, just like children who live in numerous urban and suburban areas across the country, have a greater risk of suffering from ozone- and particulate-related adverse health effects than do adults.

Ozone and PM2.5 are general air quality issues for the Knoxville metropolitan area. This pollution is caused by numerous air emissions sources, both local and distant. Air emissions from the TSCA Incinerator appear to contribute little to the region's ozone and PM2.5 problems.

ATSDR's concern stems partly from the fact that ozone and PM2.5 levels are generally highest during the afternoon hours on sunny summer days, when most children are not in school and are likely to be playing outdoors. Another reason for concern is that people with asthma have been identified as a sensitive population for both ozone and PM2.5 exposure, and asthma is more prevalent among children than among adults (Mannino et al. 2002). Finally, children might not seek or understand information in important air quality forecasts. These factors are of concern because asthmatic children or children who engage in moderate to strenuous exercise (e.g., swimming and running) during poor air quality days are at risk for respiratory problems.

Fortunately, many resources are available to help prevent children from exposure to unhealthful levels of ozone and PM2.5. As noted earlier, TDEC issues air quality forecasts, and the local media usually broadcast them. Parents should encourage their children, especially asthmatic children, to play indoors on days when levels are predicted to be unhealthful. Further, EPA's Web site now includes a tremendous amount of information on ozone, PM2.5, and related air quality issues. Adults are encouraged to access this information, whether from their home computers or those at local libraries, at www.epa.gov/airnow. Additionally, EPA has recently launched a Web site that targets health-related air pollution information to children. The site, *Air Quality Index for Kids!*, is available in English and Spanish at www.epa.gov/airnow/aqikids.

VIII. Conclusions

ATSDR has reached the following conclusions regarding the TSCA Incinerator:

1. The TSCA Incinerator efficiently destroys organic wastes, and in so doing releases trace amounts of contaminants into the air. Nevertheless, an extremely large volume of high-quality environmental data, both measured and modeled, confirm that the amounts of contamination released during both routine and non-routine operations have not harmed local residents. Accordingly, **ATSDR classifies releases from the TSCA Incinerator as creating no apparent public health hazard.** This is the conclusion category ATSDR uses when environmental exposures are known to occur, but not at levels expected to be harmful.

2. Because of potentially unhealthful levels of ozone and fine particulate matter, general air quality in the Knoxville metropolitan area is sometimes poor. Such air quality problems are not, however, unique to Knoxville: they are found in many urban and suburban settings in the United States. The occasionally poor air quality does not result from a single source (e.g., the TSCA Incinerator), but rather results from industrial and motor vehicle emissions over a broad area. People exposed to the infrequently elevated ozone and fine particulate matter levels could experience adverse health effects, such as lung irritation, aggravated asthma conditions, and difficulty breathing. Health effects are expected to be most likely among sensitive populations, which include children, the elderly, and people with respiratory conditions.

3. TDEC's collection of air samples at existing DOE sampling locations provides an excellent opportunity to verify independently the quality of DOE's ambient air monitoring measurements for metals. While general trends from the two data sets are qualitatively similar, TDEC should independently verify the accuracy of DOE's measurements, whether through using more sensitive laboratory analytical methods or by other means (e.g., performing critical technical oversight of DOE's sampling and analytical procedures, sending a small number of "split samples" from DOE's filters to an independent laboratory).

4. The Public Health Action Plan (Section X) outlines completed, ongoing, and future actions that various agencies will take to evaluate environmental health issues related to this site.

IX. Recommendations

ATSDR recommends the following actions, either to provide greater confidence in this PHA's conclusions or to ensure that residents are not exposed to unhealthful levels of contaminants in the future. The recommendations are classified into two categories:

Public Health Recommendations

DOE, EPA, and TDEC should continue operating their routine ambient air monitoring networks at ETTP to measure metals and radionuclides — two groups of contaminants that the TSCA Incinerator does not destroy.

TDEC should continue to issue air quality warnings on days when ozone or fine particulate concentrations in the Knoxville metropolitan area are expected to reach potentially unhealthful levels.

Local residents should heed air quality warnings issued by TDEC, which typically encourage residents (especially children, the elderly, and those with respiratory conditions) to remain indoors and to avoid any moderate or strenuous exercise. It is especially important for parents to communicate these warnings to their children, who often either do not seek or do not understand information on air quality.

TDEC should independently verify the quality of DOE's ambient air monitoring data for metals. This can be done several ways, such as achieving lower detection limits in its metals monitoring network (particularly for arsenic, cadmium, and chromium), performing critical technical oversight of DOE's sampling and analytical procedures, or sending a small number of "split samples" from DOE's filters to an independent laboratory.

Recommendations to Help Improve Communications on Environmental Health Issues

Even though the TSCA Incinerator does not present a public health hazard, some community members remain very concerned about the site's air emissions. Providing the public with annual fact sheets summarizing environmental conditions at the TSCA Incinerator might help address these concerns. Accordingly, TDEC should issue annual fact sheets that document the environmental status of the TSCA Incinerator. The fact sheets should address issues such as inspection outcomes, regulatory compliance issues, and other important agency oversight activities.

After independently verifying the accuracy of DOE's ambient air monitoring data for metals, TDEC document its findings in its annual environmental monitoring reports. Any notable discrepancies should be documented and explained.

For purposes of transparency, both DOE and TDEC should improve the annual reporting on their environmental monitoring networks. Recommended improvements include identifying the specific sampling and analytical methods used, presenting the method detection limits, and better documenting data quality (e.g., completeness fractions, estimated measurement precision, and comments on measurement accuracy).

X. Public Health Action Plan

This Public Health Action Plan describes specific actions that have been taken, are scheduled to be taken, or should be taken by numerous parties, including ATSDR, DOE, EPA, and TDEC. The purpose of this plan is to document past public health activities and set priorities to ensure that ongoing operation of the TSCA Incinerator will not cause harmful human health effects to occur in the future. This plan addresses issues specific to the TSCA Incinerator — it does not consider the many other public health actions that pertain to the other ORR facilities.

Actions Completed

From 1991 to the present, DOE has completed several tests to measure emissions from the incinerator. ATSDR, an independent panel chartered by the Governor of Tennessee, and DOE have modeled how these emissions move through the air. DOE, EPA, and TDEC have conducted extensive ambient air monitoring to characterize the TSCA Incinerator's potential air quality impacts.

In June 1997, TDEC prepared a report titled *Responses to the 101 Questions from Citizens Presented to the Tennessee Department of Environment and Conservation*. The report addresses health, environmental, and operational concerns regarding the TSCA Incinerator.

In January 1998, an independent panel chartered by the Governor of Tennessee prepared a report that evaluated community health concerns related to the TSCA Incinerator.

In March 2004, ATSDR conducted a site tour of the TSCA Incinerator and presented preliminary information on this PHA to the Public Health Assessment Working Group.

Actions Ongoing

DOE, EPA, and TDEC continue to conduct ambient air monitoring near the TSCA Incinerator.

ORRHES continues to meet to provide a forum for communication and collaboration between citizens and the agencies that are conducting public health activities at ORR.

To fulfill permit renewal requirements, DOE has plans to prepare a human health risk assessment and ecological risk assessment of selected environmental releases from the TSCA Incinerator. Both risk assessments will be completed after environmental agencies approve DOE's written risk assessment plans.

Recommendations for Further Action

DOE, EPA, and TDEC should continue their routine ambient air monitoring for metals and radionuclides in the vicinity of the TSCA Incinerator.

TDEC should prepare annual fact sheets documenting the environmental status of the TSCA Incinerator. These fact sheets should address inspection outcomes, regulatory compliance issues, and other agency oversight activities. If requested, ATSDR will assist TDEC with preparing a

visually appealing fact sheet for the first year, which will then be usable as a template in the future.

TDEC should independently verify the accuracy of DOE's ambient air monitoring data for metals. Once this is done, TDEC should summarize its evaluation in future annual environmental monitoring reports.

TDEC should continue to issue air quality warnings on days when ozone or fine particulate concentrations in the Knoxville metropolitan area are expected to reach potentially unhealthful levels.

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